

CONTRACT DOCUMENTS FOR CONSTRUCTION OF

John F. Kubala WTP

Bid Item 1: Main Laboratory & Maintenance Building (Project 1)

Bid Item 2: Mini Laboratory & Admin Building Renovation (Project 2)

Project No. WUTR18004

City of Arlington

Department of Water Utilities



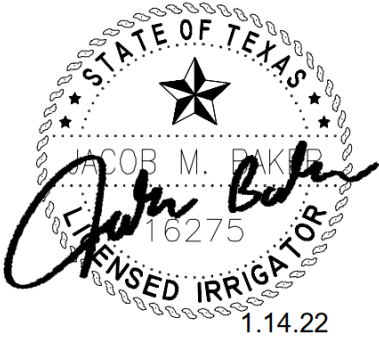
JANUARY 2022

 14 JAN 2022	Specification Sections Sealed • Division 04 Masonry • Division 05 Metals • Division 06 Wood and Plastics • Division 07 Thermal and Moisture Protection • Division 08 Doors and Windows • Division 09 Finishes • Division 10 Specialties • Division 11 Equipment • Division 12 Furnishings
JACOBS – STATE OF TEXAS REGISTERED ARCHITECT LICENSE NO. 12665	

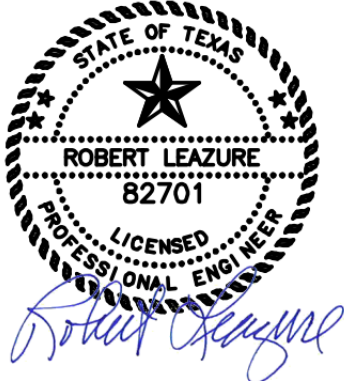
	Specification Sections Sealed • Division 23 Heating, Ventilating & Air Conditioning
JACOBS – STATE OF TEXAS ENGINEER LICENSE NO. 109782	

	Specification Sections Sealed • Division 0 Procurement & Contracting Requirements • Division 1 General Requirements
JACOBS – STATE OF TEXAS REGISTERED ARCHITECT LICENSE NO. 10107	

	Specification Sections Sealed • Division 32 Exterior Improvements
JACOBS – STATE OF TEXAS LANDSCAPE ARCHITECT LICENSE NO. 2760	

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JACOBS – STATE OF TEXAS LICENSED IRRIGATOR LICENSE NO. 16275	

	Specification Sections Sealed
	Structural
JACOBS – STATE OF TEXAS ENGINEER LICENSE NO. 140123	

THE SEAL APPEARING ON THIS DOCUMENT WAS AUTHORIZED BY ROBERT LEAZURE, P.E. 82701. (NOT VALID UNLESS SIGNED)  JACOBS – STATE OF TEXAS ENGINEER LICENSE NO. 82701	Specification Sections Sealed

 JACOBS – STATE OF TEXAS ENGINEER LICENSE NO. 138064	Specification Sections Sealed • 21 13 13 • 28 46 21.11

 JACOBS – STATE OF TEXAS ENGINEER LICENSE NO. 96712	Specification Sections Sealed • Criado Civil Specs

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Notice

The City of Arlington, Texas is requesting Proposals for the construction of the following Project:

John F Kubala WTP Main Laboratory and Maintenance Building and Mini Laboratory & Admin Building Renovations
Project No, WUTR18004

The Project includes the following Work:

Construct a water treatment plant laboratory and maintenance building. The building is a single-story building with masonry and metal panel cladding, with standing seam metal roofing. Laboratory areas include benchtops, casework, and fume hoods. Administrative areas include offices, workspace, training rooms and other facilities. Maintenance bay includes offices, and open bay areas for light maintenance and storage. Project also includes renovation of existing laboratory and administrative areas which will remain in operation during construction.

The Budget for the Project is \$10M to \$14M. The Project is to be substantially complete and ready for occupation within two years from the date of the Notice to Proceed. The Project is to be complete and eligible for final payment 30 days after the date for Substantial Completion.

Obtaining Proposal Documents

Proposal Documents for the Project can be downloaded at the following website:

<https://arlington-tx.ionwave.net/Login.aspx>

Prospective Offerors must register with this website as a plan holder, even if the Contract Documents are obtained from a plan room or other location. All official notifications, addenda, and other documents will be offered only through this website. Neither City of Arlington, Construction Manager nor Engineer will be responsible for Proposal Documents, including addenda, if any, obtained from sources other than this website.

MWBE, Pre-Proposal Conference, and Site Visit

A non-mandatory virtual outreach event will be held on Tuesday, January 25th, 2022 at 10:00am via Zoom. Please use the following link to register for the event. After successful registration, a link for the webinar will be provided.

<https://zoom.us/meeting/register/tJYlduCgrjopHtFtZYMhgM7EoAMBDXz1VY0f>

Prospective Offerors must attend a mandatory virtual pre-proposal conference held at 9:00 am on Tuesday February 1, 2022.

A tour of the Site will be held 2:00 p.m. the afternoon of the pre-proposal conference at the following location:

John F. Kubala Water Treatment Plant
7001 US Hwy 287
Arlington, Texas

Contractors must RSVP for Pre-Proposal Meeting by noon on January 31, 2022, to Ashley Brown at Ashley.Brown@arlingtontx.gov.

Questions concerning this project are to be directed to Emily Hannon at Emily.Hannon@arlingtontx.gov.

Instructions to Offerors

Sealed Proposals must be delivered to the Owner at the address below no later than 2:00 PM on Thursday, February 17, 2022, to be accepted. Proposal's will be publicly opened, and the names of the Offerors and the amount of their proposed Contract Price will be read aloud at this time and place. Proposals received after this time will be returned unopened. Address Proposals to the Owner as follows:

Office of the Director of Water Utilities
101 West Abram Street
Arlington, Texas 76010
2nd Floor of City Hall

See the Instructions to Offerors included in the Proposal Documents for detailed requirements for preparing and submitting a Proposal, proposal evaluation and award of the Contract.

Evaluation of Proposals

Selection of the Contractor will be made using a competitive sealed proposal process in accordance with Texas Government Code Chapter 2269. The selection criteria for this Project includes the following:

Rating Category	Description	Weighting Value in Points
A	Proposed Contract Price	50
B	Contractor's approach	20
C	Experience and past performance of Offeror	15
D	Experience and qualifications of proposed key personnel	15
Total		100

This Advertisement is issued by:

Owner: City of Arlington, Water Utilities Department
By: Ashley Brown
Title: Capital Projects Coordinator
First Advertisement Date: January 19, 2022
Second Advertisement Date: January 26, 2022

ARTICLE 1 – DEFINED TERMS

- 1.01 Terms used in these Instructions for Offerors have the meanings indicated in the General Conditions and Supplementary Conditions.

ARTICLE 2 – COPIES OF THE CONTRACT DOCUMENTS

- 2.01 Obtain a complete set of the Contract Documents as indicated in Section 00_52_23 Agreement. Offerors are responsible for ensuring that a complete set of documents, is used in the preparation of Proposals and assume sole responsibility for errors or misinterpretations resulting from the use of incomplete Contract Documents.
- 2.02 Owner makes copies of Contract Documents, including any Addenda and related supplemental data available for the sole purpose of obtaining Offers for completion of the Project and does not confer a license or grant permission or authorization for any other use. Authorization to download documents includes the right for Offerors to print documents for their use. Printed documents may not be re-sold under any circumstances.

ARTICLE 3 – EXAMINATION OF THE CONTRACT DOCUMENTS AND THE SITE

- 3.01 Examine the Contract Documents, the Site, and other information readily available before submitting a Proposal.
- A. Carefully study the Contract Documents.
 - B. Carefully study supplemental information, including Technical Data, record drawings from previous projects, available utility maps, reports, and studies referenced or made available to the Offeror.
 - C. Visit the Site to become familiar with any general, local, or Site conditions that may affect the cost, progress, or performance of the Work in any manner.
 - D. Become familiar with all federal, state, and local Laws and Regulations that may affect cost, progress, or the completion of Work.
 - E. Make observations and investigations, correlate knowledge, and observations with the requirements of the Contract Documents and consider these in preparation of a Proposal for the Project.
 - F. Determine that the Contract Documents, Addenda, and supplemental data are generally adequate to indicate and convey understanding of all terms and conditions for completion of Work to the degree necessary to prepare a Proposal for the Project.
 - G. Promptly notify the Construction Manager of all conflicts, errors, ambiguities, or discrepancies that the Offeror discovers in the Contract Documents, Addenda, and supplemental information.

- 3.02 The submission of a Proposal will constitute an incontrovertible representation by the Offeror that the Offeror has complied with every requirement of this Article, that without exception, the Proposal is premised upon completion of Work required by the Contract Documents, that the Offeror has given the Owner's Project Team (OPT) written notice of all conflicts, errors, ambiguities, and discrepancies that the Offeror has discovered in the Contract Documents, and that the Contract Documents adequately indicate and convey understanding of all terms and conditions required for preparation of the Proposal and completion of Work.

ARTICLE 4 – MWBE OUTREACH, PRE-PROPOSAL CONFERENCE AND SITE VISIT

- 4.01 A non-mandatory virtual outreach event will be held on Tuesday, January 25th, 2022 at 10:00am via Zoom. Please use the following link to register for the event. After successful registration, a link for the webinar will be provided.

<https://zoom.us/meeting/register/tjYlduCgrjopHtFtZYMhqM7EoAMBDXz1VY0f>

- 4.02 A mandatory pre-proposal conference will be held at the time and location indicated in the Request for Proposals. Proposals will not be accepted from Offerors who do not attend the conference. It is the Offerors' responsibility to sign in at the pre-proposal conference to verify their participation. Offerors must sign in using the name of the organization that will be submitting a Proposal. Owner will publish a list of those attending the conference to establish eligibility to submit a Proposal for this Project.
- 4.03 A tour of the Site will be conducted after the pre-proposal conference. The Site is not accessible to the public. Subsurface exploration is not allowed.

ARTICLE 5 – QUESTIONS AND INTERPRETATIONS

- 5.01 Submit all questions about the meaning or intent of the Contract Documents, Addenda, and the related supplemental data to the Emily Hannon to Emily.Hannon@arlingtontx.gov. All inquiries must be received no later than seven days prior to opening of Proposals. The City cannot guarantee a response if the inquiry or request is not submitted in time. Any interpretation of these documents will be made by addendum duly issued. The Owner will not be responsible for any other explanations or interpretations.

ARTICLE 6 – PRE-PROPOSAL ALTERNATES

- 6.01 Submit requests for alternate terms and conditions, approval of Work not in strict compliance with the Contract Documents, or requests to include products of Manufacturer's not listed as approved Manufacturers in a specification to the OPT no later than 10 days after the date the Project is first advertised. Provide all the information required for a substitution per Section 01_26_00 Change Management. OPT will consider the request and issue an Addenda as appropriate if the proposed changes to the Contract Documents are accepted. A Proposal submitted with clarifications or taking exceptions to the Contract Documents, except as modified by Addenda, will be considered non-responsive.

ARTICLE 7 – ADDENDA

- 7.01 The Owner reserves the right to issue addenda to the Contract Documents. Offerors who are current registered vendors with the City's Supplier Portal will be notified via the portal notification process and the addenda may be downloaded from the Supplier Portal. Offerors who obtained the proposal documents from the Map Room will receive the addenda via email.
- 7.02 Offeror is responsible for being aware of all addenda issued by the Owner.

ARTICLE 8 – SALES AND USE TAXES

- 8.01 The Owner generally qualifies as a tax-exempt agency as defined by the statutes of the State of Texas and is usually not subject to any city or state sales or use taxes, however certain items such as rented equipment may be taxable even though Owner is a tax-exempt agency. Assume responsibility for including any applicable sales taxes in the Contract Price and assume responsibility for complying with all applicable statutes and rulings of the State of Texas Comptroller.
- 8.02 It is the Owner's intent to have this Contract qualify as a "separated contract." Complete the following requirements for this contract to qualify:
- A. Obtain a sales tax permit from the State of Texas Comptroller if awarded this Contract.
 - B. Identify the dollar value of materials exempt from the sales tax. This information must be reported in Section 00_45_07 Compliance to State Sales Tax Code.

ARTICLE 9 – WAGE RATES

- 9.01 This Contract is subject to Texas Government Code Chapter 2258 concerning payment of prevailing wage rates. Requirements for paying the prevailing wage rates are discussed in Section 00_73_43 Wage Rate Requirements. A schedule listing the minimum wage rates for various classifications of laborers which have been established by the Owner for this Project are included in Section 00_73_46 Wage Determination Schedule. Offerors must pay not less than the minimum wage shown on this list and comply with all statutes and ruling of the State of Texas Comptroller.

ARTICLE 10 – REQUIRED AFFIDAVITS AND CERTIFICATIONS

- 10.01 Offerors must complete Section 00_45_01 Contractor Residency Statement and submit with their Proposal to indicate their state of residency and, if a non-resident Offeror, the percent by which they must be lower than resident offerors in their state to be awarded a contract.
- 10.02 Offerors must complete Section 00_45_02 Affidavit Against Prohibited Acts and submit with their Proposal. Failure to complete this form may prohibit the contractor's ability to secure the contract.
- 10.03 Offerors must complete Section 00_45_03 Conflict of Interest Questionnaire and submit with their Proposal. Failure to complete this form may prohibit the contractor's ability to secure the contract.

- 10.04 Offerors must complete Section 00_45_04 Verification Relating to Boycotting Israel and submit with their Proposal. State legislation, Chapter 2271 of the Texas Government Code prevents the City of Arlington from contracting with companies that boycotts Israel or engage subcontractors or suppliers that boycott Israel. The successful contractor must verify they do not and will not boycott Israel during term of this contract. Failure to complete this form will prevent the contractor from securing the contract.
- 10.05 Offerors must complete Section 00_45_05 Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations and submit with their Proposal. State legislation, Chapter 2252, Subchapter F of the Texas Government Code prohibits the City of Arlington from contracting with companies that engage in business with Iran, Sudan, or foreign terrorist organizations. The successful contractor must verify they do not and will not engage in business with Iran, Sudan, or foreign terrorist organizations during term of this contract. Failure to complete this form may prohibit the contractor's ability to secure the contract.
- 10.06 Offerors must complete Section 00_45_06 Non-Collusion Certification and submit with their Proposal. Failure to complete this form may prohibit the contractor's ability to secure the contract.
- 10.07 Offerors must complete Section 00_45_07 Compliance to State Sales Tax Code and submit with their Proposal. Failure to complete this form may prohibit the contractor's ability to secure the contract.
- 10.08 Offerors must complete Section 00_45_08 Prevailing Wage Rate Affidavit and submit with their Proposal. Failure to complete this form may prohibit the contractor's ability to secure the contract.
- 10.09 Offerors must complete the "MWBE Utilization Plan" and submit with their Proposal. Offerors must also submit their MWBE subcontractor's certification(s) with their Proposal. Failure to complete or submit the required forms and documentation with the Proposal will prevent the contractor from securing the contract.
- 10.10 Offerors must complete Section 00_45_09 Verification Relating to Discriminating Against Firearm or Ammunition Industries and submit with their Proposal. State legislation, Chapter 2274 of the Texas Government Code prevents the City of Arlington from contracting with companies unless the contractor verifies that it does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association, and that it will not discriminate against a firearm entity or firearm trade association during the term of the contract. Failure to complete this form will prevent the contractor from securing the contract.
- 10.11 Offerors must complete Section 00_45_10 Verification Relating to Boycotting Energy Companies and submit with their Proposal. State legislation, Chapter 2274 of the Texas Government Code prevents the City of Arlington from contracting with companies unless the contractor verifies that it does not boycott energy companies and will not boycott energy companies during the term of the contract. Failure to complete this form will prevent the contractor from securing the contract.

ARTICLE 11 – PROCUREMENT OF GOODS AND SERVICES FROM ARLINGTON BUSINESSES

- 11.01 In performing this contract, Contractor agrees to use diligent efforts to purchase all goods and services from Arlington Businesses whenever such goods and services are comparable in availability, quality, and price.

ARTICLE 12 – PROCUREMENT OF GOODS AND SERVICES FROM MINORITY/WOMEN BUSINESS ENTERPRISE OR HISTORICALLY UNDERUTILIZED BUSINESSES

- 12.01 As of March 30, 2021, the City of Arlington implemented a Minority and/or Woman-Owned Business Enterprise (MWBE) program whereby minority/woman-owned businesses are included in the City's procurement process for all basic goods and services, construction, and professional services. The City and the Office of Business Diversity will ensure MWBE companies are provided an equal opportunity to compete for all City procurements.
- 12.02 A Contract Specific Goal of 30% of the Contract Price, less Owner's Contingency Allowance and Extra Work item amounts, has been set for this project. All Offerors are required to utilize certified MWBE companies and/or persons for a minimum of 30 % of the Contract Price, less Owner's Contingency Allowance and Extra Work item amounts. With the adoption of a MWBE Program, all proposals will be reviewed to see whether said Offeror(s) has met the requirements of the City's MWBE program.
- 12.03 The Contract Specific Goal can be met through MWBE prime participation, MWBE subcontractor participation, submission of the good faith efforts documentation or a combination of any of the stated methods. An MWBE prime contractor's percentage of self-performed work can be counted towards this Contract Specific Goal. If the MWBE prime contractor's participation falls short of the Contract Specific Goal, the remaining percentage can be met utilizing MWBE subcontractors or the prime's submittal of the Good Faith Effort's Checklist and supporting documentation.
- 12.04 All Offerors must submit a MWBE Utilization Plan using form provided along with their subcontractor's MWBE certification, with their proposal, identifying the project's subcontractor and the estimated percentage of work performed by each subcontractor. The Good Faith Effort documentation and Letters of Intent (LOI's) must be submitted by the top ranked Offeror at the time and date selected during the negotiation period. If negotiations end with that Offeror, the next ranked Offeror will be notified on how and when to submit their MWBE documentation.
- 12.05 Following the formal notice to proceed, the awarded Offeror will be required to report MWBE expenditures into BG2Now. To access the system, go to <https://arlingtontx.diversitycompliance.com> in your internet browser address line. If you have never utilized the Supplier Diversity Management System, you can sign up for free webinar trainings at <https://arlingtontx.diversitycompliance.com> and click on System Training.
- 12.06 The City's Minority and Woman Business Enterprise Policy and Procedures Manual (hereinafter "MWBE Policy & Procedures Manual") is incorporated herein by reference as though written word for word. A copy of the MWBE Policy & Procedures Manual can be found at:

<https://www.arlingtontx.gov/cms/One.aspx?portalId=14481146&pageId=18054149>

ARTICLE 13 – TITLE V OF CIVIL RIGHTS ACT

13.01 The City of Arlington, in accordance with Title VI of the Civil Rights Act of 1964, 78 Stat. 252, 42 U.S.C. 2000d to 2000d-4 and Title 49, Code of Federal Regulations, Department of Transportation, Subtitle A, Office of the Secretary, Part 21, Nondiscrimination in Federally-Assisted programs of the Department of Transportation issued pursuant to such Act, hereby notifies all vendors that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, minority business enterprises will be afforded full opportunity to submit proposals in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award. Vendor will abide and ensure compliance with all terms of Appendix A of the USDOT Standard Title VI Assurances as listed below:

- A. Appendix A of the USDOT Standard Title VI Assurances: During the performance of this contract, the contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "contractor") agrees as follows:
 - 1. Compliance with Regulations: The contractor shall comply with the Regulations relative to nondiscrimination in Federally-Assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.
 - 2. Nondiscrimination: The contractor, regarding the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate either directly or indirectly in the discrimination prohibited by section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.
 - 3. Solicitations for Subcontracts, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, or national origin.
 - 4. Information and Reports: The contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the City of Arlington or the Texas Department of Transportation to be pertinent to ascertain compliance with such Regulations, orders, and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information the contractor shall so certify to the City of Arlington, or the Texas Department of Transportation as appropriate, and shall set forth what efforts it has made to obtain the information.
 - 5. Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the City of Arlington shall impose such

contract sanctions as it or the Texas Department of Transportation may determine to be appropriate, including, but not limited to:

- a. withholding of payments to the Contractor under the contract until the Contractor complies, and/or
 - b. cancellation, termination, or suspension of the contract, in whole or in part.
6. Incorporation of Provisions: The Contractor shall include the provisions of paragraphs 1 through 6 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto.

The Contractor shall take such action with respect to any subcontract or procurement as the City of Arlington or the Texas Department of Transportation may direct as a means of enforcing such provisions including sanctions for non-compliance: Provided, however, in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the City of Arlington to enter into such litigation to protect the interests of the City of Arlington, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

ARTICLE 14 – FORM 1295

- 14.01 Effective January 1, 2016, the Texas Legislature, House Bill 1295 requires all business entity to file an electronic disclosure of interested parties (Form 1295) to the Texas Ethic Commission (TEC) for any contracts requiring City Council approval. As soon as it's available, the minute order number of the contract will be forwarded to the apparent successful Offeror to complete his filing online with TEC. At that time, the contractor will be required to swear or affirm that the information entered is true and correct. A signed and notarized copy of the filing must be submitted to the City with the executed contracts within the time frame indicated on the award letter. Failure to include Form 1295 with return of the contracts will result in the contracts not being processed.

FAQ's for Form 1295 can be found on the Texas Ethics Commission web page, https://www.ethics.state.tx.us/whatsnew/FAQ_Form1295.htm. Definition of "Interested Party" can be found on Texas Ethics Commission Rules and Definitions website, <https://www.ethics.state.tx.us/tec/1295-Info.htm>

ARTICLE 15 – ALTERNATE PROPOSALS

- 15.01 Offeror must submit a Proposal that is in strict conformance with the Contract Documents as modified by Addenda. Provided this fully compliant Proposal is submitted, Offeror may submit a second Alternate Proposal in addition to the fully compliant Proposal that includes exceptions taken to the Contract Documents, offers a Proposal that is not in accordance with the terms and conditions of the Contract Documents, or offers Work that is not in strict compliance with the Contract Documents. Describe the intent and substance of the changes in the Alternate Proposal in adequate detail so the changes are clearly understood. Acceptance of the Alternate Proposal is at the sole discretion of the OPT and will not be considered if the intent of the change is not clearly understood or is deemed to not be in the Owner's best interest.

- 15.02 Alternate Proposals are to be clearly marked as Alternate Proposals and are to be submitted with the fully compliant Proposal. Do not provide a duplicate of the base Proposal. It is only necessary to identify components that are different in the proposed Alternate Proposal. Describe the intent and substance of the changes in the additional Proposal in adequate detail so the changes are clearly understood using the Proposal Deviation Request form provided by the OPT. Details in the base Proposal will remain in effect unless specifically listed in the Alternate Proposal on the Proposal Deviation Request form provided by the OPT. All provisions not specifically modified by the Alternate Proposal are to remain in effect in the Alternate Proposal.
- 15.03 The Alternate Proposal must clearly show the difference in cost of the Alternate Proposal. Include a revised Section 00_41_26 Proposal Form Exhibit A for the Alternate Proposal.

ARTICLE 16 – CONFIDENTIALITY OF PROPOSAL INFORMATION

- 16.01 In accordance with Texas Government Code 552.110, trade secrets and confidential information in Proposals are not open for public inspection. Proposals will be opened in a manner that avoids disclosure of confidential information to competing Offerors and keeps the Proposals from the public until a contract is awarded. All Proposals are open for public inspection after the Contract is awarded, however trade secrets and confidential information in Proposals may not be open for public inspection. The Owner will protect this information to the extent allowed by law.
- 16.02 Clearly indicate which specific documents are considered to be trade secrets or confidential information by stamping or watermarking all such documents with the word “confidential” prominently on each page or sheet or on the cover of bound documents. Place “confidential” stamps or watermarks so that they do not obscure any of the required information on the document, either in the original or in a way that would obscure any of the required information in a photocopy of the document. Submit all confidential information in a different binder so this confidential material is separate for the rest of the Proposal.
- 16.03 The Owner is a governmental body subject to the limitation of Texas Government Code Chapter 552 and has limited obligations regarding the protection of confidential information submitted by Offerors. The Owner, upon receiving an application or other request for the disclosure of confidential information, will promptly notify Offeror of the request as required by Texas Government Code 552.305 and request a ruling by the Texas Attorney General as to whether any such information may be released.
- 16.04 Offeror acknowledges and agrees that it will be solely responsible for submitting any arguments, authorities, or other information to the Attorney General of Texas regarding release of the information marked as confidential as provided by Texas Government Code 552.305(b) and that if disclosure is required, the OPT has no liability for releasing this information and Offeror will not be entitled to exercise any remedy for a disclosure made pursuant to the Texas Government Code Chapter 552.
- 16.05 The obligations of the OPT as recipient with respect to confidential information under the terms of this Agreement are subject to the following exceptions:
- A. If confidential information becomes a part of the public domain through publication or otherwise but through no fault of the OPT;

- B. OPT can demonstrate through suitable documentation that the confidential information was already in the OPT's possession or otherwise publicly available prior to the date of disclosure hereunder;
 - C. The confidential information is subsequently disclosed to the Owner by a third party who has a lawful right to disclose such information; or
 - D. The OPT is required to disclose the confidential information by court order or by applicable law.
- 16.06 If the OPT is requested or becomes legally compelled (by oral questions, interrogatories, requests for information or documents, subpoena, civil or criminal investigative demand, public information requests, including requests under Chapter 552 of the Texas Government Code, or similar process) or is required by a regulatory body to make any disclosure that is prohibited or otherwise constrained by this Agreement, the OPT will provide Offeror with prompt notice of this request so that it may seek an appropriate protective order or other appropriate remedy.
- 16.07 Notwithstanding any other provision of the Contract Documents, it is stipulated and agreed that by accepting a Proposal, the OPT has not and does not waive its sovereign immunity from suit and/or liability.

ARTICLE 17 – PREPARATION OF PROPOSAL

- 17.01 Complete and submit the Proposal along with all required documents identified in Section 00_41_23 Proposal Form. Prepare the Proposal, Qualifications Statement and other required Proposal Documents using the forms provided.
- 17.02 Acknowledge receipt of all Addenda by filling in the number and date of each Addendum in Section 00_41_23 Proposal Form. Provide a signature as indicated to verify that the Addenda were received. A Proposal that does not acknowledge the receipt of all Addenda may be considered non-responsive.
- 17.03 Execute the Proposal as indicated in Section 00_41_23 Proposal Form and include evidence of authority to sign. Provide the name, address, and telephone number of the individual to be contacted for any communications regarding the Proposal in the Proposal.
- 17.04 Provide evidence of the Offeror's authority and qualification to do business in the State of Texas or covenant to obtain such qualification prior to award of the Contract.
- 17.05 Prepare Section 00_41_26 Proposal Form Exhibit A by completing all information for the Project regarding the Proposed Contract Price and Proposed Contract Times. Enter the number of days proposed by the Offeror to deliver the Project as Substantially Complete and to complete the Work required for final payment in accordance with Paragraph 15.06 of the General Conditions.
- 17.06 Submit information as required in Section 00_45_13 Qualifications Statement with the Proposal to demonstrate the Offeror's qualifications to complete the Work.

ARTICLE 18 – PROPOSAL REQUIREMENTS

- 18.01 Provide one printed copy of the Proposal at the time and place set forth in the Request for Proposals. Submit the Proposal using the following guidelines:
- A. Submit Proposals in a three-ring binder. Provide a tab to separate materials responding to each of the criteria described in Article 14.
 - B. Pages are to be 8-1/2 x 11 pages using a minimum font size of 10. A limited number of 11 x 17 sheets may be used and must be folded to the size of an 8-1/2 x 11 page.
 - C. Do not exceed the number of pages for each section as indicated in Section 00_45_13 Qualifications Statement.
 - D. Do not staple, clip, or otherwise bind pages together. Do not place sheets in plastic sheet holders or envelopes.
- 18.02 Submit confidential information in accordance with Paragraph 11.01 in a separate three-ring binder. Information marked confidential, but not placed in a separate envelope will not be considered confidential and will be treated as other non-confidential information in the Proposal.
- 18.03 Provide an electronic copy of the Proposal on a flash drive. Individual file may not exceed 100 MB. Provide confidential information in a separate file. Divide files into parts if necessary.

ARTICLE 19 – PROPOSAL SECURITY

- 19.01 Offerors must submit an acceptable Proposal Security as a guarantee that, if awarded the Contract, the Offeror will contract with the Owner and provide all required bonds and evidence of insurance with the signed Contract Documents as directed in the Notice of Award. Proposal Security must be in an amount equal to 5 % of the Total Contract Amount with Allowances, Extra Work and Alternate Items, if any, as shown in Section 00 41 26 “Proposal Form Exhibit A.” The bond must be issued by a surety legally authorized to do business in Texas and meet the requirements of the General Conditions to be acceptable. Offeror and Surety bind themselves to pay the Owner the amount of the Proposal Security if Offeror fails to contract with the Owner and provide all required bonds and evidence of insurance within the times stipulated in the Contract Documents.
- 19.02 Proposal Securities are to remain in effect until the Contract is executed. Proposal Security will become void when the Contract is awarded, or all Offers are rejected.

ARTICLE 20 – DELIVERY OF PROPOSAL

- 20.01 Deliver the Proposal no later than the date and time prescribed and at the place indicated in the Request for Proposals. Enclose the Proposal and Confidential or Proprietary Information in opaque sealed envelopes plainly marked with the Project name, the name and address of the Offeror along with the Proposal Security and other required documents. Enclose these sealed envelopes in a separate envelope plainly marked on the outside with the notation “PROPOSAL ENCLOSED” if the Proposal is sent by mail or other delivery system. Address the outer envelope to the mailing address shown in the Request for Proposals. Assume full responsibility for ensuring that the Proposal arrived at the prescribed location before the prescribed time.

ARTICLE 21 – MODIFICATION OR WITHDRAWAL OF PROPOSAL

- 21.01 Proposals may be modified or withdrawn using a document executed in the same manner that a Proposal must be executed. Deliver the document to the place where Proposals are to be submitted prior to the date and time for the opening of Proposals.
- 21.02 An Offeror may withdraw its Proposal within 24 hours after Proposals are opened if the Offeror files a signed written notice with the Owner and promptly thereafter demonstrates to the reasonable satisfaction of the Owner that there was a material and substantial mistake in the preparation of its Proposal. The Proposal Security will be returned if it is clearly demonstrated to the Owner that there was a material and substantial mistake in the Offeror's Proposal. An Offeror that requests to withdraw its Proposal under these conditions may be disqualified from responding to a reissued Request for Proposals for the Work to be furnished under these Contract Documents.

ARTICLE 22 – OPENING OF PROPOSALS

- 22.01 Proposals will be opened at the time and place indicated in the Request for Proposals. The Owner will publicly acknowledge receipt of Proposals received in time to be considered. The Owner will publicly open and read aloud each Proposal as required by Texas Government Code 2269.154.

ARTICLE 23 – EVALUATION OF PROPOSALS

23.01 General Considerations:

- A. The OPT will evaluate and rank each Proposal with respect to the selection criteria within 45 days after the date Proposals are received using procurement procedures that conform to Texas Government Code Chapter 2269. In evaluating Proposals, the OPT will determine if Proposals comply with the prescribed requirements, and such alternatives, prices, and other data, as may be requested in the Proposal Form or may be requested from Offerors prior to a Notice of Award.
- B. The OPT will consider the proposed Contract Price, proposed Contract Times, qualifications of the Offerors and their Subcontractors, and other factors as described in this Article to determine which Proposal offers the best value to the Owner. The Proposals will be evaluated for each rating category with the maximum point value for each category as indicated in the following table:

Rating Category	Description	Point Value
A	Proposed Contract Price and Contract Times	50
B	Contractor's approach to the Project	20
C	Experience and past performance of Offeror	15
D	Experience and qualifications of proposed key personnel	15
Total		100

- C. The proposed Contract Price and proposed Contract Times are to be provided in 00 41 26 "Proposal Form Exhibit A". Points will be awarded for each rating category.
- D. OPT may conduct such investigations as it deems necessary to establish the responsibility, qualifications, and financial ability of consultants, individuals, or entities proposed to furnish parts of the Work in accordance with the Contract Documents.
- E. OPT, at its discretion, may also choose to conduct interviews with the top-ranking Offerors to provide the Offerors a better opportunity to demonstrate they can provide the best value to the Owner for this Project.
 - 1. Should the OPT choose to conduct interviews with the top-ranking Offerors, they will be notified of:
 - a. The time and place for the interview;
 - b. Interview format and agenda;
 - c. Questions to answer at the interview; and
 - d. Individuals that are expected to participate in the interview as a minimum.
 - 2. Failure to participate in the interview may result in disqualification from consideration for the Project.
- F. Submission of a Proposal indicates the Offeror's acceptance of the evaluation technique and methodology as well as the Offeror's recognition that some subjective judgments must be made by the OPT during the evaluation.

23.02 Evaluation for Rating Categories:

- A. Rating Category A - Proposed Contract Price and Contract Times:
 - 1. OPT will consider the Offeror's proposed Contract Price and proposed Contract Times for completion of the project as well as any specified intermediate milestones in determining best value to the Owner.
 - 2. The OPT will consider the Contract Price offered and demonstrated ability to complete projects for the Contract Price.
 - 3. The Contract Price will be used in the best value determination and will be the Contract Price awarded unless this amount is changed during negotiations between the Contractor and Owner. Negotiations, if any, will be conducted in accordance with Government Code 2269.155 and will only be for changes in scope and associated changes in Contract Time or Contract Price.
 - 4. The evaluation of proposed Contract Price will consider percentages of change orders for projects as an indicator of ability to complete the Project within the Contract Price.
 - 5. The OPT will consider the proposed Contract Times and the demonstrated ability to complete projects on time.
 - 6. OPT will use the number of days proposed by Offeror to calculate the Substantial Completion and Final Completion dates from the date of the Notice to Proceed. These dates will define the Contract Times. Liquidated Damages as defined in Section 00_52_23 Agreement will start to accrue after these dates.

7. OPT will consider earlier completion dates in the best value determination for the Project. The value of this early completion will be determined using the Offerors' proposed completion dates, approach for construction and the Owner's cost to provide Construction Management Services. This value for early completion will be used to adjust the Contract Price when evaluating the proposed Contract Price.
 8. Consideration will also be given to the demonstrated ability of the Offeror to complete projects on time, resources available for this Project, and the Offeror's capacity.
- B. Rating Category B - Project Approach:
1. OPT will consider the Offeror's approach to constructing, completing, and commissioning projects, including, but not limited to:
 - a. Construction contract administration;
 - b. Construction site safety and risk management;
 - c. Quality management;
 - d. Management of Subcontractors and Suppliers;
 - e. Resolving construction issues and resolving disputes and claims.
 2. OPT will consider the Offeror's approach to constructing the project. In describing the Offeror's approach to constructing the project include the approach and timing for construction of the Main Laboratory and Maintenance Building as well as the Mini Laboratory and Administration Building Renovations.
- C. Rating Category C - Experience/Past Performance of Offeror:
1. OPT will consider the experience and past performance of the Offeror as a company, including, but not limited to:
 - a. Offeror's current experience and performance on similar projects;
 - b. Qualifications of the offered management team;
 - c. Organization's operating philosophy and approach to managing changes in project scope;
 - d. Financial stability and approach to financial management of projects;
 - e. Safety programs and past safety performance; and
 - f. Experience on claims and litigation.
 - g. Offeror's ability to meet specific goals on similar projects, such as MWBE participation, time completion incentives, etc. and whether those goals were met.
 2. Companies that cannot meet the requirements for similar projects as defined in Section 00_45_13 Qualifications Statement may be disqualified as non-responsive.

D. Rating Category D - Experience and Qualifications of Proposed Key Personnel:

1. OPT will consider the experience and qualification of the proposed Project Manager, Project Superintendent, Safety Manager, and Quality Control Manager (Key Personnel) for this Project, including, but not limited to:
 - a. Education, training, and personal experience in delivering similar projects while serving in the capacity for which they are being proposed;
 - b. Demonstrated ability to complete quality projects on time and within budget as demonstrated by proposal information and reference checks for offered individuals;
 - c. Demonstrated leadership, character, and capability of proposed individuals; and
 - d. Availability and commitments to other projects.
 - e. Inclusion of Key Personnel subcontractors/subconsultants identified on the MWBE Utilization plan, if any.

ARTICLE 24 – AWARD OF CONTRACT

- 24.01 The Offeror selected for award of the Contract will be the Offeror whose offer provides the best value to the Owner based on the selection criteria and the ranking. The Owner is not bound to accept the lowest priced Proposal if that Proposal is not in the best interest of the Owner as determined by the Owner. If the Owner determines that it is unable to reach a contract satisfactory to the Owner with the selected Offeror, then the Owner will terminate discussions with the selected Offeror and proceed to the next Offeror in order of selection ranking until an agreement is reached or the Owner has rejected all Proposals.
- 24.02 Owner reserves the right to reject any and all Proposals, including without limitation, non-conforming, non-responsive, or conditional Proposals. The Owner may also reject the Proposal of any Offeror if the Owner believes that it would not be in the best interest of the Owner to make an award to that Offeror. The Owner reserves the right to waive all formalities.
- 24.03 More than one Proposal for the same Work from an individual or entity under the same or different names will not be considered, except as Alternate Proposals in accordance with Article 9. Reasonable grounds for believing that any Offeror has an interest in more than one Proposal for the Work shall be cause for disqualification of that Offeror and the rejection of all Proposals in which that Offeror has an interest.

ARTICLE 25 – PROPOSALS TO REMAIN SUBJECT TO ACCEPTANCE

- 25.01 All Proposals will remain subject to acceptance for 60 days, but the Owner may, at its sole discretion, release any Proposal and return the Proposal Security prior to the end of this period.

ARTICLE 26 – EXECUTING THE AGREEMENT

- 26.01 The Notice of Award to the Successful Offeror will be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents that are identified in the Agreement. The Successful Offeror shall sign and deliver the required number of counterparts of the Agreement and attached documents to the Owner within 15 days. The Owner will deliver two fully signed counterparts to the Successful Offeror within 10 days after receiving the signed documents from the Successful Offeror.
- 26.02 When the Successful Offeror delivers the executed Agreement to the Owner, it must be accompanied by the required bonds and required certificates of insurance. Article 6 of the General Conditions sets forth the Owner's requirements as to performance, payment, maintenance and other bonds and insurance. Provide performance and payment bonds for this Project that fully comply with the provisions of Texas Government Code Chapter 2253. Administration of Bonds will conform to Texas Government Code Chapter 2253 and the provisions of these Contract Documents.

ARTICLE 27 – PROPOSAL TABULATION / PROPOSAL EVALUATIONS

- 27.01 A tabulation of all proposals will be available on City's web page <http://www.arlington-tx.gov/finance/purchasing/bidding-procurement/public-works-transportation-bidding-opportunities/> within five working days of the day Proposals are received and opened.
- 27.02 Evaluation scoring will be available on City's web page <http://www.arlington-tx.gov/finance/purchasing/bidding-procurement/public-works-transportation-bidding-opportunities/> within seven working days after the contract is awarded.

END OF SECTION



MWBE SPECIAL CONTRACT PROVISIONS:
PROPOSALS
POLICY STATEMENT

On March 30, 2021, the Arlington City Council approved the resolution to adopt the City's Minority/Woman Business Enterprise (MWBE) Policy & Procedures Manual. This MWBE Policy seeks to reduce race- and gender-based barriers and foster participation with minority and woman-owned businesses in contracting and procurement opportunities with the City of Arlington by increasing the capacities of such firms to perform as prime vendors and subcontractors as well as suppliers.

The City of Arlington reaffirms that it will not, nor will its contractors, discriminate based on race, age, color, religion, sex, national origin, ancestry, gender, disability, or place of birth in the award and performance of contracts.

Every locally funded contract will be evaluated by the City of Arlington's Office of Business Diversity (OBD) to determine the appropriate method for enhancing MWBE participation, including progress towards the achievement of the annual aspirational MWBE goal and other program objectives.

Procedures for implementation, including good faith efforts requirements, information submitted with bid proposals, reporting procedures, etc., shall be consistent with the procedures utilized in the City's <MWBE Policy & Procedures Manual>.

MWBE PROJECT GOAL

The City's MWBE goal, for this project is 30 %.

Trades identified for this solicitation includes: carpentry, concrete paving, drywall & acoustics, electrical, fencing, fire protection, HVAC, landscaping, masonry, metal fabrication, plumbing, and utilities.

In making a determination that the contractor has made a good-faith effort to meet the City's MWBE goals, the Office of Business Diversity shall consider specific documentation concerning the steps taken to obtain MWBE participation, with a consideration of the following factors listed on Good Faith Effort Form.

If a contractor fails to submit the Good Faith Efforts checklist, with document, by the deadline for submission will be considered non-responsive.

The contractor's MWBE commitment percentage is based on the total value of the contract including any change orders and modifications throughout the contract agreement.

The criteria used to set a MWBE Contract Specific Goal shall include business availability, the nature of the contract, the City's past experiences with MWBE participation in similar contracts, price competitiveness, subcontracting opportunities, progress towards meeting the annual goal and other relevant factors.

A contractor cannot require a MWBE to sign an exclusive arrangement for the purpose of a bid/proposal submittal or enter a non-compete arrangement post award.

SUBMITTAL OF REQUIRED DOCUMENTATION

The following documents must be received by the assigned City Project Manager or Department Designee within the allocated times shown in order for the bid or proposal to be considered responsive to the specification. The Offeror shall DELIVER OR EMAIL the MWBE documentation to the assigned City Project Manager or Department Designee; a faxed copy will not be accepted.

MWBE Utilization Plan	Initial Plan should be submitted with proposal documents at time of opening. Final Plan will be requested during the negotiating period. <u>Should be sent to agent of record.</u>
Good Faith Effort Form and supporting documentation (if participation is less than stated goal)	Received on requested date and time during the negotiating period. <u>Should be sent to agent of record.</u>
Intent to Perform as a Subcontractor (Goods & Services)	Received on requested date and time during the negotiating period. <u>Should be sent to agent of record.</u>

Failure to submit the required MWBE documentation, based on the requested time and date, will result in the proposal being considered non-responsive and negotiations with firm ending.

MWBE CERTIFICATIONS

The City will recognize MWBE companies that have received one or more certifications from the following organizations:

- North Central Texas Regional Certification Agency (NCTRCA),
- State of Texas Historically Underutilized Business (HUB),
- Texas Department of Transportation (TxDOT),
- DFW Minority Supplier Development Council (MSDC), and
- Woman's Business Council Southwest.

The City reserves the right to review, accept, or reject any certification from agencies not listed.

POST AWARD COMPLIANCE

If change orders, amendments, or any Contract modifications are issued, the contractor has a contractual commitment to meet and/or exceed their MWBE utilization goal. Contractor is obligated to immediately notify OBD, in writing, of any agreed increase or decrease in the scope of work that will impact the MWBE participation on the contract.

The Contractor cannot terminate, substitute, or change the terms of the MWBE Utilization Plan prior to or after Contract award without the prior written consent of the OBD. If the Contractor is unable to meet its MWBE commitment with existing MWBEs, the Contractor shall satisfy its commitment, as it relates to scope of work changes, modifications, and or amendments, by soliciting new MWBEs, must submit a Request for Approval of Change to MWBE Utilization Plan for review and written approval from the OBD.

All payments must be submitted to our supplier diversity portal B2GNow: <https://arlingtontx.diversitycompliance.com/>

For vendors who are not users of B2Gnow and would like to be added, please send an email to The Office of Business Diversity mwbe@arlingtontx.gov. Please include your first name, last name, email address, full company address and phone number to be added when you email the City of Arlington. Any missing information will result in your account not being created.

For training on how to utilize B2Gnow, please sign up at <https://arlingtontx.diversitycompliance.com/> and click on System Training.



Office of Business Diversity

MWBE UTILIZATION PLAN

Project Name _____

Project No: _____ Date: _____

LEGEND

MWBE = Minority/Woman Business Enterprise

* Ethnicity = Native American (AI), Asian Pacific/Indian (AS), African American (BL), Hispanic (HI), Caucasian Female (WO), or Non- Minority (N/A)

Prime Contractor	MWBE (Yes/No)

LIST ALL SUBCONTRACTING OPPORTUNITIES (use additional sheets if necessary):

Name of Company and Description of Work Type	Potential MWBE Firm Ethnicity* (Yes/No)	Anticipated Dollar (\$) of Work

Please complete this form and include with proposal, as an attachment.

Upon formal award of said project, the proposer will submit a Prime, Subs & MWBE Report identifying the Local and/or MWBE subcontractor(s) that will perform the listed work. By signing below, the recommended proposer shall agree to meet their Local and/or MWBE goal based on the information provided on this document.

Name of Company's Main Contact Person _____

Signature of Main Contact Person _____



MINORITY/WOMEN BUSINESS ENTERPRISE (MWBE)

Minority and/or Woman-owned Business Enterprises are encouraged to participate in all City procurement solicitation. In order to be identified as a certified Minority/Woman Business Enterprise with the City of Arlington, Texas; this form, along with a copy of the selected certification, should be included with the bid/proposal.

PLEASE CHECK THE APPROPRIATE ETHNICITY AND/OR GENDER:

☐ American Indian ☐ Asian ☐ Black ☐ Hispanic ☐ Woman Owned

Certification Status: Is the firm certified as a Minority, Woman, or Disadvantaged Business Enterprise by a government or business development agency? Yes No (If yes, please select specific agency)

- ☐ North Central Texas Regional Certification Agency (NCTRCA)
- ☐ State of Texas Historically Underutilized Business (HUB)
- ☐ Dallas/Fort Worth Minority Supplier Development Council (DFW MSDC) or NMSDC affiliate
- ☐ Women's Business Council – Southwest (WBC-SW) or WBENC affiliate
- ☐ Texas Department of Transportation, Disadvantaged Business Enterprise (TxDOT, DBE)
- ☐ Small Business Administration, 8(A) Program
- ☐ Other (please specify) _____

The City of Arlington encourages minority participation and utilizing MWBE subconsultants where there are opportunities on this project.

For City Use Only:

I have reviewed this Utilization Plan and found that the _____ **HAS** or **HAS NOT** complied as per the City's M/WBE Special Provisions.

Verified Goal attainment:

MBE ____% WBE ____%

Reviewer

Date:



Office of Business Diversity

LETTER OF INTENT TO SUBCONTRACT

Project Number: _____

Project Title: _____

_____ ("Prime Contractor") agrees to enter into a contractual agreement with _____ ("MWBE Subcontractor"), who will provide the following goods/services on the above-referenced contract.

(Use broad categories (ex. "electrical work", "HVAC equipment purchase", etc.) to describe the goods/services to be provided).

for an estimated amount of \$ _____ or 0.0% of the total estimated contract value.

Prime Contractor agrees to utilize said MWBE Subcontractor in the capacity indicated herein and MWBE Subcontractor agrees to work on the above-referenced contract in the capacity herein, contingent upon award of the contract to Prime Contractor.

Signature – Prime Contractor

Signature – MWBE Subcontractor

Print Name

Print Name

Title

Date

Title

Date

Office of Business Diversity

Good Faith Effort Checklist



In making a determination that the contractor has made a good-faith effort to meet the City's MWBE goals, the Office of Business Diversity shall consider specific documentation concerning the steps taken to obtain MWBE participation, with a consideration of the following factors:

If a contractor fails to submit the Good Faith Efforts checklist, with document, by the deadline for submission will be considered non-responsive.

- ☐ Contractor attended the City's pre-bid or pre-proposal meeting.
- ☐ Contractor advertised in general circulation, trade association, and/or MWBE-focused media regarding subcontracting and/or supplier opportunities.
- ☐ Contractor solicited through reasonable and available means (e.g., written notices, advertisements) M/WBEs certified in the anticipated scopes of subcontracting of the contract, within sufficient time to allow them to respond. Attach detailed Contacts Log, including date, method of contact, person contacted and contact information, and the result of the contact.
- ☐ Contractor selected those portions of the contract consistent with the available M/WBEs, including breaking down the work into economically feasible units to facilitate M/WBE participation even when the proposer would prefer to perform those scopes with its own forces. Provide description of work selected.
- ☐ Contractor provided timely and adequate information about plans, specifications, scope of work and contract requirements to interested MWBEs. Followed up initial solicitations to answer questions and encourage M/WBEs to submit proposals or bids. Attach evidence of information provided, including the date, e.g., letters, emails, telephone logs, etc.
- ☐ Contractor negotiated in good-faith with interested MWBEs that have submitted proposals or bids and thoroughly investigated their capabilities, using good business judgement, and taking into consideration the MWBE subcontractor's price quote and not rejecting reasonable quotes from interested MWBE. Evidence of such negotiations includes the names, addresses, email addresses and telephone numbers of M/WBEs with whom the vendor negotiated; a description of the information provided to M/WBEs regarding the work selected for subcontracting; and explanations as to why agreements could not be reached with M/WBEs to perform the work.
- ☐ Contractor made effort to assist interested MWBEs to obtain bonding, lines of credit, or insurance as required by the City or the vendor for performance of the contract (if applicable).
- ☐ Contractor effectively utilized the services of M/WBE assistance groups; local, state, and federal M/WBE business assistance offices and other organizations that provide assistance in the recruitment and placement of MWBEs.

Signature Prime Contractor:

Print Name:

Title

Date:

00 41 23 PROPOSAL FORM

ARTICLE 1 – PROPOSAL RECIPIENT

1.01 Offeror submits this Proposal to:

City of Arlington
Office of the Director of Water Utilities
101 West Abram Street
Arlington, Texas 76010
2nd Floor of City Hall
Attention: Ashley Brown
Bid Item 1: John F. Kubala WTP Main Laboratory and Maintenance Building Project 1
Alternate 1: John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
Project Number WUTR18004

ARTICLE 2 – OFFEROR'S ACKNOWLEDGMENTS

- 2.01 Offeror proposes and agrees, if this Proposal is accepted, to enter into an Agreement with Owner on the form included in the Contract Documents and to perform all Work specified or indicated in Contract Documents for the Contract Price indicated in this Proposal or as modified by Contract Amendment. Offeror agrees to complete the Work within the Contract Times established in the Agreement or as modified by Contract Amendment and comply with all other terms and conditions of the Contract Documents.
- 2.02 Offeror accepts all the terms and conditions of the Request for Proposals and Section 00 21 26 "Instructions to Offerors."
- 2.03 Offeror accepts the provisions of the Agreement as to liquidated damages in the event of its failure to complete Work in accordance with the schedule set forth in the Agreement.
- 2.04 Offeror acknowledges receipt of the following Addenda:

Addendum No.	Addendum Date	Signature Acknowledging Receipt

ARTICLE 3 – OFFEROR'S REPRESENTATIONS

- 3.01 Offeror has examined and carefully studied the Contract Documents and the other related data identified in the Proposal Documents.
- 3.02 Offeror has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

- 3.03 Offeror is familiar with Laws and Regulations that may affect cost, progress, and performance of the Work.
- 3.04 Offeror has carefully studied the following Site-related reports and drawings as identified in the Supplementary Conditions:
- A. Geotechnical Data Reports regarding subsurface conditions at or adjacent to the Site;
 - B. Drawings of physical conditions relating to existing surface or subsurface structures at the Site;
 - C. Underground Facilities referenced in reports and drawings;
 - D. Reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site; and
 - E. Technical Data related to each of these reports and drawings.
- 3.05 Offeror has considered the:
- A. Information known to the Offeror;
 - B. Information commonly known to contractors doing business in the locality of the Site;
 - C. Information and observations obtained from visits to the Site; and
 - D. The Contract Documents.
- 3.06 Offeror has considered the items identified in Paragraphs 3.04 and 3.05 with respect to the effect of such information, observations, and documents on:
- A. The cost, progress, and performance of the Work;
 - B. The means, methods, techniques, sequences, and procedures of construction to be employed by Offeror; and
 - C. Offeror's safety precautions and programs.
- 3.07 Offeror agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents based on the information and observations referred to in the preceding paragraphs.
- 3.08 Offeror is aware of the general nature of Work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
- 3.09 Offeror has correlated the information known to the Offeror, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
- 3.10 Offeror has given the Construction Manager written notice of all conflicts, errors, ambiguities, or discrepancies that the Offeror has discovered in the Contract Documents, and the written resolution provided by the Construction Manager is acceptable to the Offeror.
- 3.11 The Contract Documents are generally adequate to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

- 3.12 Offeror's submittal of a Proposal constitutes an incontrovertible representation by Offeror that, without exception, all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.
- 3.13 Offeror is not prohibited from being awarded this Contract under Texas Government Code Chapter 2252, Subchapter F.
- 3.14 Offeror does not boycott Israel and will not boycott Israel during the term of this Contract if awarded to the Offeror in accordance with Texas Government Code Chapter 2270.

ARTICLE 4 – BASIS OF OFFER

- 4.01 Offeror will complete the Work in accordance with the Contract Documents at the prices shown in the attached in Section 00 41 26 "Proposal Form Exhibit A":
- 4.02 Offeror agrees that the Work will be Substantially Complete and will be completed and ready for final payment in accordance with the General Conditions within the number of days indicated in Section 00 41 26 "Proposal Form Exhibit A":

ARTICLE 5 – ATTACHMENTS TO THIS PROPOSAL

- 5.01 The following documents are attached to and made a condition of this Proposal:
 - A. Section 00 41 26 "Proposal Form Exhibit A."
 - B. Section 00 43 23 "Proposal Security (Bid Bond)."
 - C. Section 00 45 01 "Contractor Residency Statement."
 - D. Section 00 45 02 "Affidavit Against Prohibited Acts."
 - E. Section 00 45 03 "Conflict of Interest Questionnaire."
 - F. Section 00 45 04 "Verification Relating to Boycotting Israel."
 - G. Section 00 45 05 "Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations."
 - H. Section 00 45 06 "Non-Collusion Certification."
 - I. Section 00 45 07 "Compliance to State Sales Tax Code."
 - J. Section 00 45 08 "Prevailing Wage Rate Affidavit."
 - K. Section 00 45 13 "Qualifications Statement."

ARTICLE 6 – VENUE

- 6.01 Offeror agrees that venue lies exclusively in Tarrant County, Texas for any legal action.

ARTICLE 7 – PROPOSAL DELIVERY

OFFEROR:

(typed or printed name of organization)

Signature:

(individual's signature)

Name:

(typed or printed)

Title:

(typed or printed)

Address for giving notices:

Phone:

Email:

(Attach evidence of authority to sign if Offeror is a corporation, partnership, or a joint venture.)

END OF SECTION

00 41 26 Proposal Form Exhibit A

Project:	John F. Kubala Water Treatment Plant: Main Laboratory/Maintenance Building and Mini Laboratory/Admin Building Renovation	Project No.:
Owner:	City of Arlington	WUTR18004
Engineer:	Jacobs	
Offeror:		

Item No.	Item Description	Lump Sum
Proposal Item 1	Project 1 - Main Laboratory and Maintenance Building	
Proposal Item 2	Project 2 - Mini Laboratory and Admin Building Renovation	
Allowance	Owner's Contingency Allowance	\$ 500,000.00
Total Proposed Contract Price (Sum of Proposal Item 1, Proposal Item 2 and Owner's Contingency Allowance)		

Contract Time
 Offeror agrees to reach Substantial Completion in _____ days
 Offeror agrees to reach Final Completion in _____ days

Proposal Submitted By

Offeror: _____
Signature: _____
Printed Name: _____
Title: _____
Date: _____

00 43 23 PROPOSAL SECURITY (BID BOND)

Bidder as Principal Name: Mailing address (principal place of business):	Surety Name: Mailing address (principal place of business):
Owner Name: City of Arlington, Texas Mailing address (principal place of business): 101 West Abram Street Arlington, Texas 76010 Attention Second floor Water Utilities	Physical address (principal place of business): Telephone (Main): Telephone (Claims):
Contract Project name and number: John F. Kubala WTP Laboratory and Maintenance Building (Project 1) and Mini Laboratory & Admin Building Renovation (Project 2) WUTR18004 Bid Due Date:	Surety's state of incorporation: <i>By submitting this bond, Surety affirms it is authorized to do business and licensed to execute bonds in the State of Texas.</i> Local Agent for Surety Name:
Bond Contract Price Offered: Penal Sum of Bond: 5% of Contract Price offered Date of Bond:	Company: Mailing address (principal place of business): Telephone (Main):
<i>The address of the surety company to which any notice of claim should be sent may be obtained from the Texas Department of Insurance by calling the following toll-free number: 1-800-252-3439.</i>	

Surety and Bidder, intending to be legally bound by this bond, do each cause this bond to be duly executed on its behalf by its authorized officer, agent, or representative. The Bidder and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally to this bond. The condition of this obligation is such that if Owner accepts the Bidder's Bid and Bidder delivers the executed Agreement and the required bonds and evidence of insurance within the time stipulated in the Bidding Documents this obligation is null and void. Payment under this bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner. Venue lies exclusively in Tarrant County, Texas for any legal action.

Bidder as Principal	Surety
Signature: _____	Signature: _____
Name: _____	Name: _____
Title: _____	Title: _____
Email: _____	Email: _____
	(Attach Power of Attorney)

END OF SECTION

00 44 00 PRIME, SUBS & MINORITY/WOMEN BUSINESS ENTERPRISE (MWBE) REPORT

Project Name _____

Project No. _____ Date: _____

LEGEND

* Answer with "YES" or "NO"

AI	American Indian	BL
NW	Native American, Women-Owned	BW
AS	Asian	HI
AW	Asian, Women-Owned	HW
WO	Women Owned	Other _____

PRIME CONTRACTOR/CONSULTANT	*Arlington Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount

LIST ALL SUBS:

Name of Company & Address	Description of Work Type	*Arl Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount	For City's Use only Prequalified (Yes/No/NA)

Name of Company & Address	Description of Work Type	*Arl Firm (Yes/ No)	*MWBE (Yes/ No)	Type (Use abbreviation in Legend)	Anticipated Amount	For City's Use only Prequalified (Yes/No/NA)

END OF SECTION

00 45 01 CONTRACTOR RESIDENCY STATEMENT

The Texas Government Code section 2252.002 governs the awarding of contracts to non-resident bidders. This law provides that, in order to be awarded a contract as low bidder, a non-resident bidder (out-of-state contractor whose corporate office or principal place of business is outside the State of Texas) bid projects in Texas at an amount lower than the lowest Texas resident bidder by the same amount that a Texas resident bidder would be required to underbid a non-resident bidder in order to obtain a comparable contract in the state in which the non-resident's principal place of business is located. The appropriate blanks in the following statement must be filled out by all out-of-state or non-resident bidders in order for those bids to meet specifications. The failure of out-of-state or non-resident contractors to do so will automatically disqualify that bidder. This does not apply to contracts involving Federal Funds.

_____ Initial here if you are Texas Residential Bidder.

_____ Initial here if you are a Non-resident contractor in _____ (give state),
our principal place of business, is required to be _____ percent lower than resident
bidders by State Law.

BIDDER

_____	By: _____
<i>Company</i>	<i>(Please Print)</i>
_____	_____
<i>Address</i>	<i>Signature</i>
_____	_____
<i>City, State, Zip Code</i>	<i>Title (Please Print)</i>

*The State Purchasing and General Services Commission defines Principal Place of Business as follows:

Principal Place of Business in Texas means, for any type of business entity recognized in the State of Texas, that the business entity:

- has at least one permanent office located in the State of Texas, from which business activities other than submitting bids to governmental agencies are conducted and from which the bid is submitted, and
- has at least one employee who works in the Texas office

*The Texas Comptroller annually publishes a list showing how each state regulates the award if governmental contracts whose principal place of business is not located in that state.

<http://comptroller.texas.gov/>

END OF SECTION

STATE OF TEXAS
COUNTY OF TARRANT

Contract: John F. Kubala WTP Main Laboratory and Maintenance Building (Project 1) and Mini Laboratory & Admin Building Renovation (Project 2)
WUTR18004

Signed this _____ day of _____ 20____.

Title: _____
(typed or printed)

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

TEXAS PENAL CODE

TITLE 8: OFFENSES AGAINST PUBLIC ADMINISTRATION

CHAPTER 36. Bribery and Corrupt Influence

36.02 Bribery

- (a) A person commits an offense if he intentionally or knowingly offers, confers, or agrees to confer on another, or solicits, accepts, or agrees to accept from another:
 - (1) any benefit as consideration for the recipient's decision, opinion, recommendation, vote, or other exercise of discretion as a public servant, party official, or voter;
 - (2) any benefit as consideration for the recipient's decision, vote, recommendation, or other exercise of official discretion in a judicial or administrative proceeding;
 - (3) any benefit as consideration for a violation of a duty imposed by law on a public servant or party official; or
 - (4) any benefit that is a political contribution as defined by Title 15, Election Code, or that is an expenditure made and reported in accordance with Chapter 305, Government Code, if the benefit was offered, conferred, solicited, accepted, or agreed to pursuant to an express agreement to take or withhold a specific exercise of official discretion if such exercise of official discretion would not have been taken or withheld but for the benefit; notwithstanding any rule of evidence or jury instruction allowing factual inferences in the absence of certain evidence, direct evidence of the express agreement shall be required in any prosecution under this subdivision.
- (b) It is no defense to prosecution under this section that a person whom the actor sought to influence was not qualified to act in the desired way whether because he had not yet assumed office or he lacked jurisdiction or for any other reason.
- (c) It is no defense to prosecution under this section that the benefit is not offered or conferred or that the benefit is not solicited or accepted until after:
 - (1) the decision, opinion, recommendation, vote, or other exercise of discretion has occurred; or
 - (2) the public servant ceases to be a public servant.
- (d) It is an exception to the application of Subdivisions (1), (2), and (3) of Subsection (a) that the benefit is a political contribution as defined by Title 15, Election Code, or an expenditure made and reported in accordance with Chapter 305, Government Code.
- (e) An offense under this section is a felony of the second degree.

36.08 Gift to Public Servant by Person Subject to His Jurisdiction

- (a) A public servant in an agency performing regulatory functions or conducting inspections or investigations commits an offense if he solicits, accepts, or agrees to accept any

benefit from a person the public servant knows to be subject to regulation, inspection, or investigation by the public servant or his agency.

- (b) A public servant in an agency having custody of prisoners commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows to be in his custody or the custody of his agency.
- (c) A public servant in an agency carrying on civil or criminal litigation on behalf of government commits an offense if he solicits, accepts, or agrees to accept any benefit from a person against whom the public servant knows litigation is pending or contemplated by the public servant or his agency.
- (d) A public servant who exercises discretion in connection with contracts, purchases, payments, claims, or other pecuniary transactions of government commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows is interested in or likely to become interested in any contract, purchase, payment, claim, or transaction involving the exercise of his discretion.
- (e) A public servant who has judicial or administrative authority, who is employed by or in a tribunal having judicial or administrative authority, or who participates in the enforcement of the tribunal's decision, commits an offense if he solicits, accepts, or agrees to accept any benefit from a person the public servant knows is interested in or likely to become interested in any matter before the public servant or tribunal.
- (f) A member of the legislature, the governor, the lieutenant governor, or a person employed by a member of the legislature, the governor, the lieutenant governor, or an agency of the legislature commits an offense if he solicits, accepts, or agrees to accept any benefit from any person.
- (g) A public servant who is a hearing examiner employed by an agency performing regulatory functions and who conducts hearings in contested cases commits an offense if the public servant solicits, accepts, or agrees to accept any benefit from any person who is appearing before the agency in a contested case, who is doing business with the agency, or who the public servant knows is interested in any matter before the public servant. The exception provided by Sec. 36.10(b) does not apply to a benefit under this subsection.
- (h) An offense under this section is a Class A misdemeanor.
- (i) A public servant who receives an unsolicited benefit that the public servant is prohibited from accepting under this section may donate the benefit to a governmental entity that has the authority to accept the gift or may donate the benefit to a recognized tax-exempt charitable organization formed for educational, religious, or scientific purposes.

36.09 Offering Gift to Public Servant

- (a) A person commits an offense if he offers, confers or agrees to confer any benefit on a public servant that he knows the public servant is prohibited by law from accepting.
- (b) An offense under this section is a Class A misdemeanor.

36.10 Non-Applicable

- (a) Sections 36.08 (Gift to Public Servant) and 36.09 (Offering Gift to Public Servant) do not apply to:
 - (1) a fee prescribed by law to be received by a public servant or any other benefit to which the public servant is lawfully entitled or for which he gives legitimate consideration in a capacity other than as a public servant;
 - (2) a gift or other benefit conferred on account of kinship or a personal, professional, or business relationship independent of the official status of the recipient; or
 - (3) a benefit to a public servant required to file a statement under Chapter 572, Government Code, or a report under Title 15, Election Code, that is derived from a function in honor or appreciation of the recipient if:
 - (A) the benefit and the source of any benefit in excess of \$50 is reported in the statement; and
 - (B) the benefit is used solely to defray the expenses that accrue in the performance of duties or activities in connection with the office which are nonreimbursable by the state or political subdivision;
 - (4) a political contribution as defined by Title 15, Election Code;
 - (5) a gift, award, or memento to a member of the legislative or executive branch that is required to be reported under Chapter 305, Government Code;
 - (6) an item with a value of less than \$50, excluding cash or a negotiable instrument as described by Section 3.104, Business & Commerce Code; or
 - (7) an item issued by a governmental entity that allows the use of property or facilities owned, leased, or operated by the governmental entity.
- (b) Section 36.08 (Gift to Public Servant) does not apply to food, lodging, transportation, or entertainment accepted as a guest and, if the donee is required by law to report those items, reported by the donee in accordance with that law.
- (c) Section 36.09 (Offering Gift to Public Servant) does not apply to food, lodging, transportation, or entertainment accepted as a guest and, if the donor is required by law to report those items, reported by the donor in accordance with that law.
- (d) Section 36.08 (Gift to Public Servant) does not apply to a gratuity accepted and reported in accordance with Section 11.0262, Parks and Wildlife Code. Section 36.09 (Offering Gift to Public Servant) does not apply to a gratuity that is offered in accordance with Section 11.0262, Parks and Wildlife Code.

END OF SECTION

CONFLICT OF INTEREST QUESTIONNAIRE For vendor doing business with local governmental entity		FORM CIQ
This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session. This questionnaire is being filed in accordance with Chapter 176 of the Local Government Code by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a). By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. See Section 176.006(a-1), Local Government Code. A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.	OFFICE USE ONLY	
1 Name of vendor who has a business relationship with local governmental entity. 	Date Received 	
2 ☐ Check this box if you are filing an update to a previously filed questionnaire. (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)		
3 Name of local government officer about whom the information is being disclosed. Name of Officer		
4 Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary. A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor? ☐ Yes ☐ No B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity? ☐ Yes ☐ No		
5 Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more. 		
6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1)		
7 Signature of vendor doing business with the governmental entity		Date

CONFLICT OF INTEREST QUESTIONNAIRE
For vendor doing business with local governmental entity

A complete copy of Chapter 176 of the Local Government Code may be found at <http://www.statutes.legis.state.tx.us/Docs/LG/htm/LG.176.htm>. For easy reference, below are some of the sections cited on this form.

Local Government Code § 176.001(1-a): "Business relationship" means a connection between two or more parties based on commercial activity of one of the parties. The term does not include a connection based on:

- (A) a transaction that is subject to rate or fee regulation by a federal, state, or local governmental entity or an agency of a federal, state, or local governmental entity;
- (B) a transaction conducted at a price and subject to terms available to the public; or
- (C) a purchase or lease of goods or services from a person that is chartered by a state or federal agency and that is subject to regular examination by, and reporting to, that agency.

Local Government Code § 176.003(a)(2)(A) and (B):

(a) A local government officer shall file a conflicts disclosure statement with respect to a vendor if:

(2) the vendor:

(A) has an employment or other business relationship with the local government officer or a family member of the officer that results in the officer or family member receiving taxable income, other than investment income, that exceeds \$2,500 during the 12-month period preceding the date that the officer becomes aware that

(i) a contract between the local governmental entity and vendor has been executed;

or

(ii) the local governmental entity is considering entering into a contract with the vendor;

(B) has given to the local government officer or a family member of the officer one or more gifts that have an aggregate value of more than \$100 in the 12-month period preceding the date the officer becomes aware that:

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor.

Local Government Code § 176.006(a) and (a-1)

(a) A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with a local governmental entity and:

(1) has an employment or other business relationship with a local government officer of that local governmental entity, or a family member of the officer, described by Section 176.003(a)(2)(A);

(2) has given a local government officer of that local governmental entity, or a family member of the officer, one or more gifts with the aggregate value specified by Section 176.003(a)(2)(B), excluding any gift described by Section 176.003(a-1); or

(3) has a family relationship with a local government officer of that local governmental entity.

(a-1) The completed conflict of interest questionnaire must be filed with the appropriate records administrator not later than the seventh business day after the later of:

(1) the date that the vendor:

(A) begins discussions or negotiations to enter into a contract with the local governmental entity; or

(B) submits to the local governmental entity an application, response to a request for proposals or bids, correspondence, or another writing related to a potential contract with the local governmental entity; or

(2) the date the vendor becomes aware:

(A) of an employment or other business relationship with a local government officer, or a family member of the officer, described by Subsection (a);

(B) that the vendor has given one or more gifts described by Subsection (a); or

(C) of a family relationship with a local government officer.

END OF SECTION

00 45 04 VERIFICATION RELATING TO BOYCOTTING ISRAEL

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP Main Laboratory and Maintenance Building Project 1
John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
WUTR18004

The State of Texas has passed legislation which is codified in Chapter 2270 of the Texas Government Code that prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor by signing below verifies that Contractor does not boycott Israel and will not boycott Israel during the term of the Contract. This verification when executed will be attached to the contract and become a part of the contract for all purposes.

Signed this _____ day of _____ 20 ____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address:

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 06 NON-COLLUSION CERTIFICATION

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP Laboratory and Maintenance Building Project 1
John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
WUTR18004

Bidder certifies that it has not been a party to any collusion among Bidders in the restraint of freedom of competition by agreement to submit a Bid at a fixed price or to refrain from submitting a Bid or with any official or employee of the Owner as to quantity, quality, or price in the prospective contract, or any other terms of said prospective contract; or in any discussion between Bidders and any official of the Owner concerning exchange of money or other thing of value for special consideration in the letting of a contract.

Certified this _____ day of _____ 20 ____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address:

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 07 COMPLIANCE TO STATE SALES TAX CODE

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: Base Proposal: John F. Kubala WTP Main Laboratory/Maintenance Building and Mini
Laboratory/Admin building Renovation and Owner's Contingency Allowance
Project Number: WUTR18004

Comply with all applicable sales, excise, and use tax requirements of the Texas Tax Code. The Bidder hereby certifies that the Contract Price is divided as follows:

Tax exempt products, materials, and services (See Notes 1 and 2)	\$	_____
Taxable products, materials, and services (See Note 3)	\$	_____
Total (See Note 4)	\$	_____

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address: _____

Phone: _____ Email: _____
(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

Notes:

1. Exempt products and materials are those items purchased for the Project which are physically incorporated into the facilities constructed for the Owner or are necessary and essential for the performance of the Work and are completely consumed at the Site. For purposes of this definition, products and materials are completely consumed if after being used once for its intended purpose it is used up or destroyed. Products and materials rented or leased for use in the performance of the Work cannot be completely consumed for the purposes of this definition.
2. Exempt services are those services performed at the Site where the Contract expressly requires the specific service to be provided or purchased by the person performing the Work or the service is integral to the performance of the Work.
3. Products, materials, and services are not tax exempt if they are used by the Contractor but are not physically incorporated into the Owner's facilities or are not consumed by construction as defined

above. Machinery or equipment and its accessories and repair and replacement parts used in the performance of the Work are not exempt.

4. The total sum of the amount for tax exempt and taxable products, materials, and services must equal the Contract Price.

END OF SECTION

Title: _____
(typed or printed)

Representing: _____
(typed or printed name of organization)

Notary Attest

Sworn to (or affirmed) and subscribed before me this _____ day of _____ , _____
(month) (year)

☐ Personally Known ☐ Produced Identification Type and No. of ID: _____

By: _____
(notary's signature)

Name: _____
(typed or printed)

Notary Public - State of: _____
(typed or printed)

My Commission expires: _____
(typed or printed) (notary seal)

END OF SECTION

00 45 09 VERIFICATION RELATING TO DISCRIMINATING AGAINST FIREARM OR
AMMUNITION INDUSTRIES

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP Laboratory and Maintenance Building Project 1
Project Number: John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
Project Number WUTR18004

The State of Texas has passed legislation, which is codified in Chapter 2274 of the Texas Government Code, that prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor, by signing below, verifies that Contractor does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association, and that it will not discriminate against a firearm entity or firearm trade association during the term of this Contract. This verification, when executed, will be attached to the Contract, and become a part of the Contract for all purposes.

Signed this _____ day of _____ 20 ____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address: _____

Phone: _____ Email: _____
(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 10 VERIFICATION RELATING TO BOYCOTTING ENERGY COMPANIES

STATE OF TEXAS

COUNTY OF TARRANT

Owner: City of Arlington, Water Utilities Department
101 West Abram Street
Arlington, Texas 76010

Contract: John F. Kubala WTP Laboratory and Maintenance Building Project 1
Project Number: John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
Project Number WUTR18004

The State of Texas has passed legislation, which is codified in Chapter 2274 of the Texas Government Code, that prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor, by signing below, verifies that Contractor does not boycott energy companies and will not boycott energy companies during the term of the Contract. This verification, when executed, will be attached to the Contract, and become a part of the Contract for all purposes.

Signed this _____ day of _____ 20 ____ .

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address:

Phone: _____ Email: _____
(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

00 45 13 QUALIFICATIONS STATEMENT

ARTICLE 1 – REQUIREMENTS FOR THE QUALIFICATIONS STATEMENT

- 1.01 The Qualifications Statement must be submitted by the apparent low Bidder with the bid and include the information as described in this Section as a minimum. Failure to submit the required information in the Qualifications Statement may result in the Owner considering the Bid non-responsive and may result in rejection of the Bid by the Owner. Bidders may be required to provide supplemental information if requested by the Owner to clarify, enhance, or supplement the information provided in the Qualifications Statement.
- 1.02 Bidders must provide the information requested in this Qualifications Statement using the forms attached to this Section. The information requested in these forms must be provided completely and in detail. Information that cannot be totally incorporated in the forms may be included as an appendix to the form. This appendix must be clearly referenced by appendix number on the form, and the appended material must include the appendix number on every sheet of the appendix. The appendix must include only the information that responds to the question or item number to which the appended information applies.
- 1.03 Bidders may provide supplemental information to the Qualifications Statement such as organizational brochures or other marketing information to help demonstrate their qualifications to the Owner. This information may not be submitted as a substitute for the information specifically requested in this Section. The reference must include the specific paragraph or section that applies to that question or item if this information is included as an appendix to the information requested in Article 2.

ARTICLE 2 – INSTRUCTIONS FOR PREPARING THE QUALIFICATIONS STATEMENT

- 2.01 Bidder's Organization and General Information:
 - A. Provide general information about the Bidder's organization using copies of Table 1. Provide the same information for each joint venture partner if the Bidder is a joint venture.
 - B. Provide information regarding the operational structure of the Bidder's organization, including a list of officers, the limits of authority for these individuals with regards to the proposed Project, documentation of authority to execute documents, and a copy of organizations' certificate of authorization to conduct business in the state in which the Project is located.
 - C. Financial Management:
 1. Provide Bidder's most recent audited financial statement and the most recent financial statement if the most recent audited financial statement is more than 2 years old.

2. Provide the Bidder's financial summary information in Table 1, including the financial indicators from the Bidder's most recent financial statement using the formulas below:

Current Ratio: $\text{Current Assets} \div \text{Current Liabilities}$

Quick Ratio: $(\text{Cash and Cash Equivalents} + \text{Accounts Receivable} + \text{Short Term Investments}) \div \text{Current Liabilities}$

3. Describe the resources that are available to the Bidder to provide adequate cash flow for the project if Bidder's Current Ratio or Quick Ratio are less than 1.0.

D. Safety:

1. Provide a narrative not to exceed four pages describing the organizations success in implementing an effective project site safety program. Provide a narrative describing the Bidder's safety program and a statement regarding the organization's commitment to safety. Bidders should not provide copies of safety manuals or programs.
2. Provide Experience Modification Ratio (EMR) and Total Recordable Frequency Rate (TRFR) history for the last 3 years for the Bidder and any proposed Subcontractors that will provide Work valued at 25 percent or more of the Contract Price. Provide this information in Table 1.
 - a. The Bidder's EMR is a computation by the insurance industry that compares a company's annual losses in workers' compensation insurance claims against its policy premiums over a three-year period, excluding the current year.
 - b. The Bidder's TRFR is a calculation of a firm's total number of OSHA-recordable injuries and illnesses over a given period (usually a year), divided by the total number of personnel-hours worked.

- E. Claims Experience and Litigation History: Provide a list of all claims or litigation involving owners on other construction projects that have been active over the last 5 years or that are currently unresolved. Include this information in Table 1. Provide a narrative describing the issues being contested and when it is anticipated that the disputes will be resolved. Claims are to include only those items which have progressed through the change management process for the project and are being disputed by the Bidder or the project owner.

- F. Past Experience with the Owner: Provide a list of projects that have been completed with the Owner over the last 5 years. Include this information in Table 1. Provide a narrative not to exceed two pages describing how this experience will impact the performance of the organization on this Project.

2.02 Project Experience:

- A. Provide a list of projects completed by the Bidder in the last 5 years using copies of Table 2.
- B. Provide detailed descriptions of projects which demonstrate the experience of the Bidder's team with construction of similar projects. Experience must include, as a minimum, the

satisfactory completion of at least 3 similar projects within the last 5 years. Companies not meeting this requirement for similar projects may be disqualified as being non-responsive. Similar projects must include:

1. Laboratory Casework and Equipment including fume hoods, lab exhaust systems and water/gas distribution piping.
 2. Renovations of existing laboratories and control rooms while facility remains in operation
- C. Provide a narrative not to exceed two pages for each project describing up to five specific projects that qualify as similar projects. Projects selected must demonstrate the capabilities of the organization.

2.03 Experience and Qualifications of Proposed Key Personnel:

- A. Provide a narrative not to exceed four pages describing the Bidder's project management structure and the qualifications of the project management team for this Project. Include an organization chart showing the relationship between Bidder and key Subcontractors and Suppliers.
- B. Provide information on the key personnel proposed for this project on Tables 3 through 7. Key personnel include the Project Manager, Project Superintendent, Safety Manager, and Quality Control Manager. The Bidder may provide information on an alternate individual if the Bidder is not able to commit to one individual for the Project at the time the Bid is submitted. Qualifications of these individuals will be considered in evaluating the qualifications of the Bidder. The Bidder must commit to providing the services of the proposed key personnel or alternate for the life of the Project as a condition of qualification. Failure to provide the proposed key personnel may result in the disqualification of the Bidder and will provide the basis for termination of the Contract at the discretion of the Owner.
- C. Include a list of the current project assignments for each of the individuals proposed, the anticipated completion date for this assignment and the percentage of the time they will have available to devote to this Project. The Project Superintendent must be dedicated to this Project full time for the duration of the Project. If any other key personnel are not devoted solely to this Project, indicate how time is to be divided between this Project and their other assignments. Specifically address how and when individuals currently on other assignments will transition into this Project.
- D. Provide resumes not exceeding two pages for each individual proposed for the key personnel positions and their alternates. Resumes must describe the qualifications of the individual and include the following as a minimum: technical experience, managerial experience, education and formal training, primary language, and a work history which describes project experience, including the roles and responsibilities for each assignment. Additional information highlighting the experience which makes them the best candidate for the assignment should also be included. Focus on projects on which individuals proposed have had significant involvement in the last 5 years and which demonstrate their experience with similar projects.
- E. Identify individuals that will fill one or more of these key roles and describe their ability to handle multiple responsibilities. Provide a written narrative describing the percentage of

the time that will be devoted to each role and their qualifications to fulfill each role if an individual is to fulfill more than one of the key personnel roles.

- F. Provide a tabulation of the projects on which these key personnel have been personally involved using copies of Table 7. This tabulation is to include the name and a current telephone number for references for each of these project assignments.
- G. Provide a narrative not to exceed two pages for each project the proposed individuals have worked on that qualify as similar projects. Specifically identify the role and responsibilities of the individual on these similar projects. Projects selected must demonstrate the capabilities of the proposed key personnel.
- H. Provide a narrative not to exceed ten pages to describe the overall performance of the individuals on these projects. This narrative may include references to letters of recommendation, project awards, and other references to demonstrate experience in constructing a project which meets the Owner's expectations for a quality project constructed on time and within budget.

2.04 Bidder's Ability to Complete Projects within the Contract Price and Contract Times

- A. Provide a tabulation of budget performance on projects completed by the Bidder within the last 5 years using copies of Table 8 to demonstrate the ability of the Bidder to complete projects for the Contract Price. Notes may be added to each line item to describe circumstances for change orders beyond the control of the Bidder.
- B. Provide a tabulation of all projects completed by the Bidder within the last 5 years on Table 9 to demonstrate performance in completing projects on time. Notes may be added to the tabulations to indicate the reasons for not meeting original contract completion dates.

ARTICLE 3 – QUALIFICATIONS STATEMENT REQUIREMENTS

- 3.01 Provide the Qualifications Statement using the referenced tables and narrative descriptions as described in this Section. Pages are to be 8-1/2 x 11 pages using a minimum font size of 10. Provide a tab to separate materials responding to each of the rating categories listed in Article 2.
- 3.02 Additional information may be included in appendices attached to the Qualifications Statement. Each appendix must reference the section of the criteria to which it references.

ARTICLE 4 – FORMS

- 4.01 The following tables are attached to this Section:

Table	Description
1	General Information
2	Current Projects and Project Completed within the last 5 Years
3	Proposed Project Managers
4	Proposed Project Superintendents
5	Proposed Project Safety Managers
6	Proposed Project Quality Control Managers
7	Project Information for Key Personnel
8	Demonstration of Budget Performance

Table	Description
9	Demonstration of On-Time Performance

ARTICLE 5 – CERTIFICATION

- 5.01 By submitting this Qualifications Statement and related information, Bidder certifies that it has read this Qualifications Statement and that Bidder's responses are true and correct and contain no material misrepresentations, and that the individual signing below is authorized to make this certification on behalf of the Bidder's organization.

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Designated Representative:

Name: _____

Title: _____

Address for giving notices:

Phone: _____ Email: _____

(Attach evidence of authority to sign if Bidder is a corporation, partnership, or a joint venture.)

END OF SECTION

Table 1 - General Information

Organization			
Legal Name of Business:			
Form of Business: ☐ Joint Venture ☐ Corporation ☐ General Partnership ☐ Limited Partnership			
Date Business was formed:		State under which Business was formed:	
Is this Business authorized to operate in the Project location: ☐ Yes ☐ No ☐ Pending			
Is this Business licensed as a general contractor in the Project location: ☐ Yes ☐ No ☐ Pending ☐ N/A			
List of companies, firms, or organizations that own any part of this Business.			
Name of company, firm, or organization.			Percent ownership
Principal Office			
Primary contact		Main telephone number	
Email address		Website address	
Business address of principal office			
Regional Office			
Primary contact		Main telephone number	
Email address		Website address	
Business address of regional office			
Business History			
List of names that this Business currently has or anticipates operating under over the history of the Business, including the names of related companies presently doing business:			
Names of organization		From date	To date
Indicators of Organization Size			
Average number of current full-time employees			
Average estimate of revenue for the current year			

Table 1 - General Information Cont'd

Previous Contracting Experience			
Years of experience in projects similar to the proposed project:			
As a general contractor		As a joint venture partner	
Has this or a participating or a predecessor organization ever been disqualification as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this, a participating or a predecessor organization been released from a bid in the past 5 years? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever defaulted on a project or failed to complete any contract awarded to it? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Has this or a participating or a predecessor organization ever refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Is this or a participating or a predecessor organization currently involved in any litigation or contemplating litigation? ☐ Yes ☐ No If yes provide full details in a separate attachment.			
Previous History with Owner			
List projects that have been completed with the Owner over the last 5 years. If more than 5 projects, list only the most recent.			
	Project Name		Year
1			
2			
3			
4			
5			
Previous Claims History and Litigation Experience			
List all claims or litigation involving owners on other construction projects that have been active over the last 5 years or that are currently unresolved.			
	Description of Claim or Litigation		Status
1			
2			
3			
4			
5			

Table 1 - General Information Cont'd

Surety								
Surety Name								
Mailing address (principal place of business):					Physical address (principal place of business):			
Telephone (main number)					Telephone (claims notices)			
Name of Local Agent for Surety								
Telephone				Email				
Surety is a corporation organized and existing under the laws of the state of:								
Is surety authorized to provide surety bonds in the Project location? ☐ Yes ☐ No								
Is surety listed in the U.S. Department of the Treasury's Listing of Approved Sureties (Department Circular 570 "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies")? ☐ Yes ☐ No								
Insurance								
Name of Insurance Provider								
Provider is a corporation organized and existing under the laws of the state of:								
Is Provider licensed or authorized to issue insurance policies in the Project location?						☐ Yes ☐ No		
Does Provider have an A.M. Best Rating of A-VIII or Better?						☐ Yes ☐ No		
Mailing Address (principal place of business)								
Physical Address(principal place of business)								
Telephone (Main)								
Telephone (for Notice of Claims)								
Local Agent for Provider								
Address for Local Agent								
Telephone for Local Agent								
Construction Site Safety Experience								
Provide Bidder's Experience Modification Ratio (EMR) and Total Recordable Frequency Rate (TRFR) for the last 3 years and the EMR and TRFR history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 25% or more of the Contract Price.								
Year	Bidder		Subcontractor		Subcontractor		Subcontractor	
	EMR	TRFR	EMR	TRFR	EMR	TRFR	EMR	TRFR
1								
2								
3								

Table 1 - General Information Cont'd

Financial Summary Information for Bidder		
Date of Bidder's most current financial statement:		
Date of Bidder's most current audited financial statement:		
Financial indicators from the most current financial statement:		
Bidder's Current Ratio (Current Assets / Current Liabilities)		
Bidder's Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) / Current Liabilities)		
Describe the resources that are available to the Bidder to provide adequate cash flow for the project if Bidder's Current Ratio or Quick Ratio are less than 1.0:		
Disadvantaged Business Certifications		
Name of Certification	Certifying Agency	Certification Date
☐ Disadvantage Business Enterprise:		
☐ Minority Business Enterprise:		
☐ Woman Business Enterprise:		
☐ Disabled Veteran Owned Business:		
☐ Historically Underutilized Business:		
☐ Small Business Enterprise:		
☐ Other:		
☐ None		

Table 2 - Current Projects and Project Completed within the last 5 Years

Name of Organization					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					
Project Owner			Project Name		
General Description of Project					
Project Cost			Date Project Completed		
Key Project Personnel	Project Manager	Project Superintendent	Safety Manager	Quality Control Manager	
Name					
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)					
	Name	Title/Position	Organization	Telephone	Email
Owner					
Designer					
Construction Manager					

Table 3 - Proposed Project Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as project manager			
Years of experience with this organization			
Number of similar projects as project manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment		Percent of time used for this project	Estimated project completion date
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Table 4 - Proposed Project Superintendents

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as project superintendent			
Years of experience with this organization			
Number of similar projects as project superintendent			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Table 5 - Proposed Project Safety Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as project safety manager			
Years of experience with this organization			
Number of similar projects as project safety manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as project safety manager			
Years of experience with this organization			
Number of similar projects as project safety manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Table 6 - Proposed Project Quality Control Managers

Name of Organization			
Primary Candidate			
Name of individual			
Years of experience as quality control manager			
Years of experience with this organization			
Number of similar projects as quality control manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	
Alternate Candidate			
Name of individual			
Years of experience as quality control manager			
Years of experience with this organization			
Number of similar projects as quality control manager			
Number of similar projects in other positions			
Current Project Assignments			
Name of assignment	Percent of time used for this project	Estimated project completion date	
Reference Contact Information (listing names indicates approval to contact named individuals as a reference)			
Name		Name	
Title/Position		Title/Position	
Organization		Organization	
Telephone		Telephone	
Email		Email	
Project		Project	
Candidate's role on project		Candidate's role on project	

Table 7 - Project Information for Key Personnel

Name of Organization							
Provide information on all projects completed by the Organization within the last 5 years.							
Project Owner				Project Name			
General Description of Project:							
Project Budget and Schedule Performance							
Budget History	Amount	% of Bid Amount	Schedule Performance		Date	Days	
Original Contract Price			Notice to Proceed				
Change Orders			Contract Substantial Completion Date at Notice to Proceed				
Owner Enhancements			Contract Final Completion Date at Notice to Proceed				
Unforeseen Conditions			Change Order Authorized Substantial Completion Date				
Design Issues			Change Order Authorized Final Completion Date				
Total			Actual / Estimated Substantial Completion Date				
Final Cost			Actual / Estimated Final Completion Date				
Key Project Personnel							
		Project Manager	Project Superintendent	Safety Manager	Quality Control Manager		
Name							
Percentage of time devoted to the project.							
Percentage of time proposed for this Project.							
Did Individual start and complete the project?							
If not, who started or completed the project in their place?							
Reason for change?							
Reference Contact Information (listing names indicates approval to contacting the names individuals as a reference)							
	Name	Title/Position	Organization	Telephone	Email		
Owner							
Designer							
Construction Manager							
Surety							
Issues / disputes resolved or pending resolution by arbitration, litigation or dispute review boards							
Number of issues resolved		Total amount involved in resolved issues		Number of issues pending		Total amount involved in issues pending	

Table 8 - Demonstration of Budget Performance

Name of Bidder							
Provide information on all projects completed by the Bidder within the last 5 years.							
Owner Name	Project Description	Original Contract Price	Value of Change Orders			Total Change Orders	Percent of Changes to Original Contract Price
			Owner Enhancements	Unforeseen Conditions	Design Issues		
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							

Table 9 - Demonstration of On-Time Performance

Name of Organization							
Provide information on all projects completed by the Organization within the last 5 years.							
Owner Name	Project Description	Original Contract Date for Substantial Completion	Original Contract Date for Final Completion	Amended Contract Date for Substantial Completion	Amended Contract Date for Final Completion	Actual Contract Date for Substantial Completion	Actual Contract Date for Final Completion
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							
Notes:							

00 52 23 AGREEMENT

This Agreement is between City of Arlington, Texas (Owner) and [name of Contractor to be inserted at time of contract execution] (Contractor).

Owner and Contractor agree as follows:

ARTICLE 1 – WORK

- 1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is designated as follows:

John F. Kubala WTP Laboratory and Maintenance Building Project 1
John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
Project Number WUTR18004

ARTICLE 2 – ENGINEER

- 2.01 The Engineer for this Project is:

Jacobs
1999 Bryan Street, Suite 1200
Dallas, Texas 75201

ARTICLE 3 – PROGRAM MANAGER / CONSTRUCTION MANAGER

- 3.01 The Program Manager for this Project is:

Arcadis US Inc.
12400 Coit Road, Suite 1200
Dallas, Texas 75251

- 3.02 The Construction Manager for this Project is:

Freese and Nichols, Inc.
801 Cherry Street Suite 2800
Fort Worth, Texas 76102

ARTICLE 4 – CONTRACT TIMES

- 4.01 Contract Times:

- A. The Work is required to be substantially complete, and the project is required to be complete and ready for final payment in accordance with the General Conditions within the number of days shown in Section 00 52 26 "Agreement Exhibit A".

- 4.02 Liquidated Damages:

- A. Owner and Contractor recognize that the Contract Times specified for Substantial Completion and Final Completion are of the essence in the Contract. Owner and Contractor recognize that the Owner will suffer financial loss if the Work is not completed within the Contract Times specified in this Agreement as may be adjusted in accordance with the General Conditions. Owner and Contractor also recognize the delays, expense, and

difficulties involved in proving in a legal or arbitration preceding the actual loss suffered by Owner if the Work is not completed within the Contract Times. Accordingly, instead of requiring proof of the amount of these damages, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. Contractor agrees to pay Owner \$3,500.00 for each day that expires after the time specified in this Agreement for Substantial Completion until the Work is substantially complete.
 2. Contractor agrees to pay Owner \$1,500.00 for each day that expires after the time specified in this Agreement for Final Completion until the Work is completed and ready for final payment in accordance with the General Conditions.
- B. Liquidated damages for failing to timely attain Substantial Completion and Final Completion are not additive and will not be imposed concurrently.
- C. OPT will determine whether the Work has been completed within the Contract Times. Assessment of liquidated damages by the Owner does not waive the Owner's right to assess or collect additional damages which the Owner may sustain by the failure of the Contractor to perform in accordance with the terms of the Contract.

4.03 Actual Damages:

- A. Owner may be subject to additional financial losses as the result of permit violations or loss of service to City of Arlington customers. These losses were not included in the liquidated damages amount established in this Agreement. Contractor will be required to compensate the Owner for these losses if they occur due to the Contractor's failure to reach Substantial Completion by the date specified in this Agreement.

4.04 No Waiver

- A. Nothing in this Article shall be considered a waiver of any other damages which Owner may be entitled under the Contract or in law.

ARTICLE 5 – CONTRACT PRICE

- 5.01 Owner will pay Contractor for completion of the Work in accordance with the Contract Documents at the prices shown in Section 00_52_26 Agreement Exhibit A. The Contract Price has been computed in accordance with the General Conditions. Contractor acknowledges that for unit price items, estimated quantities are not guaranteed and are solely for the purpose of comparing Bids, and that final payment will be based on actual quantities determined in accordance with the Contract Documents.

5.02 Owner's Contingency Allowance

- A. The Owner has established its Contingency Allowance in the amount shown in Section 00_52_26 Agreement Exhibit A. Owner's Contingency Allowance is for the sole use of Owner to cover unanticipated costs. The Owner's Contingency Allowance will be used to pay the Contractor for approved change proposals requiring a change in Contract Price per Section 01_26_00 Change Management.

ARTICLE 6 – PAYMENT PROCEDURES

- 6.01 Submit Applications for Payment in accordance with the General Conditions. Applications for Payment will be processed by the Construction Manager per Section 01 29 00 “Application for Payment Procedures.” Payment is based on the total earned value of Work completed in the previous month in accordance with the Schedule of Values.
- 6.02 Payment will be made for the total earned value of Work completed in the previous month after deducting:
 - A. Retainage calculated per this Agreement;
 - B. Set-offs determined in accordance with the General Conditions; and
 - C. The total amount of payments previously made.
- 6.03 Progress payments will be made in an amount equal to 95 percent of the total earned value to date for completed Work and properly stored materials. The remaining 5 percent of the total earned value to date will be held as retainage. Owner may increase retainage to 10 percent if progress on the Project is considered to be unsatisfactory. Owner will deposit retainage in excess of 5 percent in an interest-bearing account. Interest earned by that account will be paid to the Contractor in accordance with Texas Government Code Chapter 2252.
- 6.04 Release or reduction in retainage is contingent upon the consent of surety to the reduction in retainage. Submit a Consent of Surety Company to Reduction of or Partial Release of Retainage form as provided by or approved by the Construction Manager.
- 6.05 Owner will pay the remainder of the Contract Price as recommended by Construction Manager in accordance with the General Conditions upon Final Completion and acceptance of the Work.

ARTICLE 7 – PAYMENT OF INTEREST

- 7.01 All moneys not paid when due as provided in the General Conditions will earn interest at the rate specified in Texas Government Code Chapter 2251. Interest accrual will cease upon payment by the Owner.

ARTICLE 8 – TEXAS GOVERNMENT CODE CHAPTER 552

- 8.01 Compliance with Texas Government Code Chapter 552:
 - A. In this section, Contracting Information shall have the same meaning as defined in Texas Government Code § 552.003(7).
 - B. The Contractor must preserve all Contracting Information related to the contract as provided by the records retention requirements applicable to the governmental body for the duration of the contract;
 - C. The Contractor must promptly provide to the governmental body any Contracting Information related to the contract that is in the custody or possession of the entity on request of the governmental body; and
 - D. On completion of the contract, Contractor shall either
 - 1. Provide at no cost to the Owner all Contracting Information related to the contract that is in the custody or possession of the Contractor; or

2. Preserve the Contracting Information related to the contract as provided by the records retention requirements applicable to the City of Arlington.
- E. The requirements of Subchapter J, Chapter 552, Government Code, may apply to this contract and the contractor or vendor agrees that the contract can be terminated if the contractor or vendor knowingly or intentionally fails to comply with a requirement of that subchapter.

ARTICLE 9 – RIGHT TO AUDIT

- 9.01 Contractor agrees that City will, until the expiration of three (3) years after final payment under this contract, have access to and the right to examine any directly pertinent books, documents, papers and records of Contractor involving transactions relating to this contract. Contractor agrees that City shall have access during normal working hours to all necessary Contractor facilities and shall be provided adequate and appropriate workspace in order to conduct audits in compliance with the provisions of this section. City will give Contractor reasonable advance notice of intended audits.
- 9.02 Contractor further agrees to include in subcontract(s), if any, a provision that any subcontractor agrees that City shall have access to and the right to examine any directly pertinent books, documents, papers and records of such subcontractor involving transactions to the subcontract, and further, that City shall have access during normal working hours to all subcontractor facilities, and shall be provided adequate and appropriate work space, in order to conduct audits in compliance with the provisions of this paragraph.

ARTICLE 10 – PROHIBITION ON CONTRACTS WITH CERTAIN COMPANIES

- 10.01 Texas Government Code Chapter 2270 applies to the award of government contracts to companies that boycott Israel. Section 2270.02 states that a “governmental entity may not enter into a contract with a company for goods or services unless the contract contains a written verification from the company that it: (1) does not boycott Israel; and (2) will not boycott Israel during the term of the contract.” Contractor is to certify that it does not boycott Israel and will not boycott Israel during the term of this Contract by submitting the form in Section 00 45 04 “Verification Relating to Boycotting Israel.”
- 10.02 Texas Government Code Chapter 2252, Subchapter F of the Texas Government Code prohibits any municipal government from entering into a contract for goods and services with companies that engage in business with Iran, Sudan, or foreign terrorist organizations. Contractor is to certify that it does not engage in business with Iran, Sudan, or foreign terrorist organizations and will not engage in business with Iran, Sudan, or foreign terrorist organizations during the term of the Contract by submitting the form in Section 00 45 05 “Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, or Foreign Terrorist Organizations.”
- 10.03 Texas Government Code Chapter 2274 prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor verifies that Contractor does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association, and that it will not discriminate against a firearm entity or firearm trade association during the term of this Contract by submitting the form in Section 00 45 09 “Verification Relating to Discrimination Against Firearm or Ammunition Industries.”

- 10.04 Government Code Chapter 2274 prevents any municipal government from entering into a contract for goods and services unless the contractor makes certain verifications. The Contractor verifies that Contractor does not have a practice, policy, guidance, or directive that that Contractor does not boycott energy companies and will not boycott energy companies during the term of the Contract by submitting the form in Section 00 45 10 "Verification Relating to Boycotting Energy Companies."

ARTICLE 11 – VENUE

- 11.01 Contractor agrees that venue lies exclusively in Tarrant County, Texas for any legal action.

ARTICLE 12 – CONTRACT DOCUMENTS

12.01 Contract Documents:

- A. Specifications Sections listed in Section 00 01 10 "Table of Contents" except as specifically excluded in Paragraph 12.02.
- B. Drawings listed in the Sheet Index on the Drawings.
- C. Addenda (Numbers 00 91 01 to 00 91 [XX], inclusive).
- D. Appendices listed in Section 00 01 10 "Table of Contents" except as specifically excluded in Paragraph 12.02.
- E. The following are also Contract Documents which may be delivered or issued on or after the Effective Date of the Contract:
 - 1. Notice to Proceed.
 - 2. Contract Amendment(s).
 - 3. Change Order(s).
 - 4. Field Order(s).
 - 5. Work Change Directive(s).
- F. There are no Contract Documents other than those listed above in this Paragraph. The Contract Documents may only be amended, modified, or supplemented as provided in the General Conditions.

12.02 Bidding Requirements and Informational Documents:

- A. The following Bidding Requirements are not Contract Documents, but are considered "Contracting Information" under Texas Government Code Chapter 552:
 - 1. Request for Proposals.
 - 2. Section 00 21 26 "Instructions to Offerors."
 - 3. Section 00 41 23 "Proposal Form."
 - 4. Section 00 41 26 "Proposal Form Exhibit A"
 - 5. Section 00 43 23 "Proposal Security (Bid Bond)."
 - 6. Section 00 44 00 "Prime, Subs & Minority/Women Business Enterprise (MWBE) Report

7. Section 00 45 01 "Contractor Residency Statement."
 8. Section 00 45 02 "Affidavit Against Prohibited Act"
 9. Section 00 45 03 "Conflict of Interest Questionnaire."
 10. Section 00 45 04 "Verification Relating to Boycotting Israel"
 11. Section 00 45 05 "Prohibition on Contracts with Companies Engaged in Business with Iran, Sudan, Or Foreign Terrorist Organizations"
 12. Section 00 45 06 "Non-Collusion Certification"
 13. Section 00 45 07 "Compliance to State Sales Tax Code."
 14. Section 00 45 08 "Prevailing Wage Rate Affidavit."
- B. The following documents are provided for information only and are not part of the Contract Documents, but are considered "Contracting Information" under Texas Government Code Chapter 552:
1. Documents listed in Section 00 73 00 "Supplementary Conditions" Paragraph SC-5.03 Paragraph B.

ARTICLE 13 – CONTRACTOR'S REPRESENTATIONS

13.01 The Contractor makes the following representations:

- A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.
- B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. Contractor is familiar with Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Contractor has carefully studied the following Site related reports and drawings as identified in the Supplementary Conditions:
 1. Geotechnical Data Reports regarding subsurface conditions at or adjacent to the Site;
 2. Drawings of physical conditions relating to existing surface or subsurface structures at the Site;
 3. Underground Facilities referenced in reports and drawings;
 4. Reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site; and
 5. Technical Data related to each of these reports and drawings.
- E. Contractor has considered the:
 1. Information known to Contractor;
 2. Information commonly known to contractors doing business in the locality of the Site;
 3. Information and observations obtained from visits to the Site; and
 4. The Contract Documents.

- F. Contractor has considered the items identified in Paragraphs 8.01.D and 8.01.E with respect to the effect of such information, observations, and documents on:
 - 1. The cost, progress, and performance of the Work;
 - 2. The means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and
 - 3. Contractor's safety precautions and programs.
- G. Based on the information and observations referred to in the preceding paragraphs, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.
- H. Contractor is aware of the general nature of Work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
- I. Contractor has correlated the information known to the Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
- J. Contractor has given the Construction Manager written notice of all conflicts, errors, ambiguities, or discrepancies that the Contractor has discovered in the Contract Documents, and the written resolution provided by the Construction Manager is acceptable to the Contractor.
- K. The Contract Documents are generally adequate to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
- L. Contractor's entry into this Agreement constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.
- M. Contractor is not ineligible to be awarded this Contract under Texas Government Code Section 2155.004.
- N. Contractor is not ineligible to be awarded this Contract under Texas Government Code Chapter 2252, Subchapter F.

The Effective Date of the Contract is [date to be inserted at the time of contract execution].

IN WITNESS WHEREOF, the parties of these presents have executed this agreement:

Contractor

Company Name

Tax Identification Number

Signature

Printed or Typed Name

Printed or Typed Title

City of Arlington, Texas

Attest

Director

Alex Busken, City Secretary

Approved as to Form

Teris Solis, City Attorney

Signature

STATE OF TEXAS
COUNTY OF TARRANT

Contractor Acknowledgement

BEFORE ME, the undersigned authority, a Notary Public in and for the State of Texas, on this day personally appeared _____,

- ☐ who is known to me;
- ☐ who was proved to me on the oath of _____ (name of person identifying the acknowledging person); or
- ☐ who was proved to me through _____ (description of identity card or other document issued by the federal or state government containing the picture and signature of the acknowledging person) to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he/she executed same for and as the act and deed of _____, a corporation of _____ County, Texas, and as _____ thereof, and for the purposes and consideration therein expressed and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the _____ day of _____, 20____.

Notary Public in and for the State of Texas

Notary's Printed Name

City Acknowledgement

BEFORE ME, the undersigned authority, a Notary Public in and for the State of Texas, on this day personally appeared [Craig M. Cummings], known to me to be a person and officer whose name is subscribed to the foregoing instrument, and acknowledged to me that he/she executed same for and as the act of the City of Arlington, Texas, a Texas municipal corporation, and as Director of Water Utilities thereof, and for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the _____ day of _____, 20____.

Notary Public in and for the State of Texas

Notary's Printed Name

END OF SECTION

00 52 26 Agreement Exhibit A

Project:	John F. Kubala Water Treatment Plant: Main Laboratory/Maintenance Building and Mini Laboratory/Admin Building Renovation	Project No.:
Owner:	City of Arlington	WUTR18004
Engineer:	Jacobs	
Contractor:		

Item No.	Item Description	Lump Sum
Contract Item 1	Project 1 - Main Laboratory and Maintenance Building	
Contract Item 2	Project 2 - Mini Laboratory and Admin Building Renovation	
Allowance	Owner's Contingency Allowance	\$ 500,000.00
Total Contract Price (Sum of Contract Item 1, Contract Item 2 and Owner's Contingency Allowance)		

Contract Time	
Contractor agrees to reach Substantial Completion in	days
Contractor agrees to reach Final Completion in	days

Contractor:	
Signature:	
Printed Name:	
Title:	
Date:	

00 61 13 PERFORMANCE BOND

STATE OF TEXAS

COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____
of the City of _____, County of _____
State of _____ hereinafter referred to as "PRINCIPAL," and
_____, a corporate
surety/sureties organized under the laws of the State of _____ and authorized to do
business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and
firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County,
Texas, hereinafter referred to as "CITY," in the amount of _____ DOLLARS
(\$ _____), lawful money of the United States, to be paid in Arlington, Tarrant County,
Texas, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors,
assigns, administrators and successors, jointly and severally; and firmly by these presents, the condition
of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the ____
day of _____, 20____, a copy of which is attached hereto and made a part hereof, to
furnish all materials, equipment, labor, supervision, and other accessories necessary for the construction
of: John F. Kubala WTP Laboratory and Maintenance Building Project 1

 John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
 City of Arlington Project No. WUTR18004

in the City of Arlington, Texas, as more particularly described and designated in the above referenced
contract such contract being incorporated herein and made a part hereof as fully and to the same extent
as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL shall well, truly and faithfully perform and fulfill all of the undertakings, covenants, terms,
conditions and agreements of the above referenced Contract in accordance with the plans,
specifications and Contract documents during the original term thereof, and any extension thereof
which may be granted with or without notice to SURETY, and during the life of any guaranty required
under the Contract, and shall also well and truly perform and fulfill all the covenants, terms, conditions
and agreements of any and all authorized modifications of such Contract that may hereafter be made,
notice of which modifications to SURETY being hereby waived, then this obligation shall be void,
otherwise to remain in full force and effect; and in case PRINCIPAL shall fail to do so, it is agreed that
CITY may do such work and supply such materials and charge the same against PRINCIPAL and SURETY
on this obligation, and PRINCIPAL and SURETY hereon shall be subject to the liquidated damages

mentioned in the Contract for each day's failure on its part to comply with the terms and provisions of such Contract.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that SURETY, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans, specifications, drawings, etc., accompanying same shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by SURETY as the agent resident in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20__.

WITNESS

PRINCIPAL

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

WITNESS

SURETY

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

NOTE: Date of Performance Bond must NOT be prior to date of Contract

END OF SECTION

00 61 16 PAYMENT BOND

STATE OF TEXAS

COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____
of the City of _____, County of _____
State of _____ hereinafter referred to as "PRINCIPAL," and

_____, a corporate surety/sureties organized under the laws of the State of _____ and authorized to do business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County, Texas, hereinafter referred to as "CITY," and unto all persons, firms and corporations who may furnish materials for or perform labor upon the buildings, structures or improvements referred to in the attached Contract, in the penal sum of _____ DOLLARS (\$_____), lawful money of the United States, to be paid in Arlington, Tarrant County, Texas, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally; and firmly by these presents, the condition of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the _____ day of _____, 20____, a copy of which is attached hereto and made a part hereof, to furnish all materials, equipment, labor, supervision, and other accessories necessary for the construction of:

John F. Kubala WTP Laboratory and Maintenance Building Project 1
John F. Kubala WTP Mini Laboratory and Admin Building Renovation Project 2
City of Arlington Project No. WUTR18004

in the City of Arlington, Texas, as more particularly described and designated in the above referenced contract such contract being incorporated herein and made a part hereof as fully and to the same extent as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL shall well, truly and faithfully perform its duties and make prompt payment to all persons, firms, subcontractors, corporations and claimants supplying labor and materials in the prosecution of the work provided for in the above referenced Contract and any and all duly authorized modifications of such Contract that may hereafter be made, notice to SURETY of such modifications being hereby waived, then this obligation shall be void, otherwise to remain in full force and effect.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that such SURETY, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans, specifications, drawings, etc. accompanying same shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder.

This Bond is given pursuant to the provisions of Chapter 2253 of the Government Code, as amended. The terms "payment bond beneficiary", "public work labor", and "public work material", as used herein, are in accordance with and as defined in the relevant provisions of Chapter 2253 of the Government Code.

The undersigned and designated agent is hereby designated by SURETY as the resident agent in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20____.

WITNESS

PRINCIPAL

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

WITNESS

SURETY

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

The Resident Agent of the SURETY in either Tarrant or Dallas County, Texas, for delivery of notice and service of process is:

Name

Address

NOTE: Date of Payment Bond must NOT be prior to date of Contract

END OF SECTION

00 61 19 MAINTENANCE BOND

STATE OF TEXAS
COUNTY OF TARRANT

KNOW ALL BY THESE PRESENTS:

THAT _____
of the City of _____, County of _____
State of _____ hereinafter referred to as "PRINCIPAL," and
_____, a corporate
surety/sureties organized under the laws of the State of _____ and authorized to do
business in the State of Texas, hereinafter referred to as "SURETY," (whether one or more), are held and
firmly bound unto the CITY OF ARLINGTON, TEXAS, a municipal corporation located in Tarrant County,
Texas, hereinafter referred to as "CITY," in the amount of 50 percent of the Contract Price, lawful money
of the United States, to be paid in Arlington, Tarrant County, Texas, for the payment of which sum well
and truly to be made, we bind ourselves, our heirs, executors, assigns, administrators and successors,
jointly and severally; and firmly by these presents, the condition of this obligation is such that,

WHEREAS, PRINCIPAL entered into a certain written Contract with the City of Arlington dated the ____
day of _____, 20____, a copy of which is attached hereto and made a part hereof, to furnish
all materials, equipment, labor, supervision, and other accessories necessary for the construction of:

John F. Kubala WTP Laboratory/Maintenance Building and Mini Laboratory/Admin Building
Renovation
City of Arlington Project No. WUTR18004

in the City of Arlington, Texas, as more particularly described and designated in the above referenced
contract such contract being incorporated herein and made a part hereof as fully and to the same extent
as if written herein word for word:

NOW THEREFORE,

If PRINCIPAL will maintain and keep in good repair the work herein contracted to be done and
performed for a period beginning 364 days after Substantial Completion and continuing for a period of
two years and perform all necessary work and repair any defective condition growing out of or arising in
any part of the construction of said improvement then this obligation shall be void, otherwise it shall
remain in full force and effect. It being understood that the purpose of this section is to cover all
defective conditions arising by reason of defective materials, work or labor performed by PRINCIPAL. In
case PRINCIPAL shall fail to do so, it is agreed that CITY may do such work and supply such materials and
charge the same against PRINCIPAL and SURETY on this obligation.

Provided, further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

And, that SURETY, for value received, hereby stipulates and agrees that no change, extension of time,
alteration or addition to the terms of the Contract or to the work performed thereunder, or the plans,
specifications, drawings, etc., accompanying same shall in any way affect its obligation on this Bond; and
it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of
the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by SURETY as the agent resident in either Tarrant or Dallas County to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, this instrument is executed on this the ____ day of _____, 20____.

WITNESS

PRINCIPAL

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

WITNESS

SURETY

By:

Signature

Typed / Printed Name

Title

Address

City, State, Zip

By:

Company

Signature

Typed / Printed Name

Title

Address

City, State, Zip

NOTE: Date of Maintenance Bond must NOT be prior to date of Contract

MAINTENANCE BOND REQUIREMENTS

1. A maintenance bond is defined as a performance bond that extends the correction period for a specified period beyond the one-year correction period described in the General Conditions.
2. The maintenance bond must meet the same requirements for bonds as the Contractor's performance bond described in the Contract Documents.
3. Surety for the maintenance bond must be the same surety that provides performance and payment bonds as set forth in the General Conditions.
4. Indemnification provisions of the General Conditions apply to the maintenance bond period.
5. Correct Defective Work during the one-year correction period in accordance with the General Conditions.
6. Correct Defective Work during the maintenance bond period just as required for the one-year correction period specified in the General Conditions. Provide labor and materials required to correct Defective Work or correct Work that does not function as required by the Contract Documents.
7. Correction of Defective Work during the maintenance bond period does not extend the correction period as is required under the provisions of the one-year correction period described in the General Conditions.
8. Promptly correct damages to the Site or adjacent areas that Contractor has arranged to use through construction easements or other agreements. Promptly correct damages to the Work or the work of others. Make the corrections without cost to Owner.
9. Owner may correct Defective Work without notice to the Contractor in an emergency where delay would cause serious risk of loss or damage.
10. Include the cost for correcting Defective Work during the maintenance bond period in the Contract Price. Include all costs associated with providing the maintenance bond in the Contract Price.
11. Reimburse the Owner for engineering and special services required to be furnished by the Owner which are directly attributable to the corrective Work.
12. Remedy for Failure to Correct Defective Work:
 - a. Owner may correct Defective Work if the Contractor fails or refuses to perform corrective Work within 10 days after Owner notifies the Contractor of Defective Work.
 - b. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this paragraph are to be paid by the Contractor or its surety. These claims, costs, losses, and damages include costs of repair and the cost of replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's Defective Work. Owner is not required to obtain the lowest price for the Work performed when exercising its rights or remedies under this paragraph.
13. Provide insurance as required by the Contract Documents during the maintenance bond period. Provide evidence of insurance prior to beginning corrective Work if evidence of insurance is not current.

END OF SECTION

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

- A. A term with initial capital letters, including the term's singular and plural forms, has the meaning indicated in this paragraph wherever used in the Bidding Requirements or Proposal Requirements or the Contract Documents. In addition to the terms specifically defined, terms with initial capital letters in the Contract Documents may include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Documents issued prior to the receipt of Bids or Proposals which clarify or modify the Bidding Requirements, Proposal Requirements, or the proposed Contract Documents.
 2. *Agreement*—The document signed by Owner and Contractor that establishes the Contract Price and Contract Times and designates the specific documents that are Contract Documents.
 3. *Application for Payment*—The documents used by Contractor to request payments from Owner and the supporting documentation required by the Contract Documents.
 4. *Bid; Proposal*—An offer submitted to the Owner for the Project setting forth the Contract Price and Contract Times for the Work to be performed.
 5. *Bidding Documents; Proposal Documents*—The Bidding Requirements or Proposal Requirements, the proposed Contract Documents, and Addenda.
 6. *Bidding Requirements; Proposal Requirements*—The Invitation to Bid or Request for Proposals, Instructions to Offerors, Bid Security or Proposal Security, Bid Form or Proposal Form and attachments, and required certifications and affidavits.
 7. *Bid Security; Proposal Security*—The financial security provided by Offeror at the time the Bid or Proposal is submitted and held by Owner until the Agreement is executed and the evidence of insurance and bonds required by the Contract Documents are provided.
 8. *Change Order*—A document issued on or after the Effective Date of the Contract and signed by Owner and Contractor which modifies the Work, Contract Price, Contract Times, or terms and conditions of the Contract.
 9. *Change Proposal*—A document submitted by Contractor in accordance with the requirements of the Contract Documents:
 - a. Requesting an adjustment in Contract Price or Contract Times;
 - b. Contesting an initial decision concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents;
 - c. Challenging a set-off against payment due; or
 - d. Seeking other relief with respect to the terms and conditions of the Contract.
 10. *Claim*—A demand or assertion by Owner or Contractor submitted in accordance with the requirements of the Contract Documents. A demand for money or services by an entity other than the Owner or Contractor is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning any hazardous, toxic, or dangerous waste, substance, or material.
12. *Construction Manager*—The individual or entity named as the Construction Manager in the Agreement and the consultants, subconsultants, individuals, or entities directly or indirectly employed or retained by them to provide construction management as advisor services to the Owner.
13. *Contract*—The entire integrated set of documents concerning the Work and describing the relationship between the Owner and Contractor.
14. *Contract Amendment*—A document issued on or after the Effective Date of the Contract and signed by Owner and Contractor which:
 - a. Authorizes new phases of the Work and establishes the Contract Price, Contract Times, or terms and conditions of the Contract for the new phase of Work; or
 - b. Modifies the terms and conditions of the Contract but does not make changes in the Work.
15. *Contract Documents*—Those items designated as Contract Documents in the Agreement.
16. *Contract Price*—The monetary amount stated in the Agreement and as adjusted by Modifications, and increases or decreases in unit price quantities, if any, that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
17. *Contract Times*—The number of days or the dates by which Contractor must achieve specified Milestones, achieve Substantial Completion, and complete the Work.
18. *Contractor*—The individual or entity with which Owner has contracted to perform the Work.
19. *Contractor's Team*—Contractor, Subcontractors, Suppliers, and individuals or entities directly or indirectly employed or retained by Contractor, Subcontractors, or Suppliers to perform part of the Work, or anyone for whose acts they may be liable.
20. *Cost of the Work*—The sum of costs incurred for the performance of the Work as allowed by Article 13.
21. *Day*—A day of 24 hours measured from midnight to the next midnight.
22. *Defective*—When applied to Work, refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. Does not conform to the Contract Documents;
 - b. Does not meet the requirements of applicable inspections, reference standards, tests, or approvals referred to in the Contract Documents; or
 - c. Has been damaged prior to Construction Manager's recommendation of final payment unless responsibility for the protection of the Work has been assumed

by Owner at Substantial Completion in accordance with Paragraphs 15.03 or 15.04.

23. *Design Professional*—The individuals or entity named as the Architect or Engineer in the Agreement and the subconsultants, individuals, or entities directly or indirectly employed or retained by Design Professional to provide design or other technical services to the Owner. Design Professional has responsibility for design and technical issues related to the Contract Documents.
24. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work. Shop Drawings and other documents generated by Contractor's Team are not Drawings.
25. *Effective Date of the Contract*—The date indicated in the Agreement on which the Contract becomes effective.
26. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including Shop Drawings and other Submittals, that are in an electronic or digital format.
27. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging or Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.
28. *Engineer's Estimate*—The amount budgeted by the Owner for the construction of the Project.
29. *Field Order*—A document issued by Construction Manager or Design Professional requiring changes in the Work that do not change the Contract Price or the Contract Times.
30. *Final Completion*—The point where the Work is complete in accordance with the Contract Documents, items and documents required by the Contract Documents have been accepted by the Owner, and the Project is ready for Final Payment.
31. *Hazardous Environmental Condition*—The presence of Constituents of Concern at the Site in quantities or circumstances that may present a danger to persons or property exposed to Constituents of Concern. The presence of Constituents of Concern at the Site necessary for the execution of the Work or to be incorporated into the Work is not a Hazardous Environmental Condition provided these Constituents of Concern are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract.
 - a. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.

- b. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
- 32. *Indemnified Costs*—All costs, losses, judgments, and damages resulting from claims or demands against Owner's Indemnitees. These costs include fees for design professionals, attorneys, and other professionals and any legal, court, arbitration, or other dispute resolution costs.
- 33. *Laws and Regulations; Laws or Regulations*—Applicable laws, statutes, rules, regulations, ordinances, codes, permits, and binding decrees, resolutions, and orders of governmental bodies, agencies, authorities, and courts having jurisdiction over the Project.
- 34. *Liens*—Charges, security interests, or encumbrances upon Contract related funds, real property, or private property.
- 35. *Manufacturer*—The individual or entity that designs, casts, fabricates, manufactures, assembles, tests, and provides materials or equipment to be incorporated in the Work.
- 36. *Milestone*—A principal event in the performance of the Work that Contractor is required by Contract to complete by a specified date or within a specified time.
- 37. *Modification*—Change made to the Contract Documents by Contract Amendment, Change Order, Field Order, or Work Change Directive.
- 38. *Notice of Award*—The notice of Owner's acceptance of the Successful Offeror's Bid or Proposal.
- 39. *Notice to Proceed*—A notice to Contractor of the Contract Times and the date Work is to begin.
- 40. *Offeror*—An individual or entity that submits a Bid or Proposal to Owner.
- 41. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.
- 42. *Owner's Indemnitees*—Each member of the OPT and their officers, directors, members, partners, employees, agents, consultants, and subcontractors.
- 43. *Owner's Project Team (OPT)*—The Owner, Design Professional, Construction Manager, and the other entities identified in the Supplementary Conditions and the consultants, subconsultants, individuals or entities directly or indirectly employed or retained by them to provide services to the Owner.
- 44. *Progress Schedule*—A schedule prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
- 45. *Project*—The total undertaking to be accomplished for Owner under the Contract Documents.
- 46. *Project Construction Manager (PCM)*—The authorized representative of the OPT assigned to assist the Construction Manager at the Site. The term Project Construction Manager includes assistants and field staff of the Construction Manager.

47. *Project Management Information System (PMIS)*—The online project management system that will be used by OPT and Contractor to submit and share documentation and other related communications and information for this Project.
48. *Samples*—Physical examples of materials, equipment, or workmanship representing some portion of the Work that are used to establish the standards for that portion of the Work.
49. *Schedule of Anticipated Payments*—A detailed tabulation, prepared and maintained by Contractor, showing the anticipated amount of each Application for Payment and the month they will be submitted.
50. *Schedule of Documents*—A detailed tabulation, prepared and maintained by Contractor, of each required document submittal and the time requirements for review and approval of each submittal.
51. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work, and used as the basis for Contractor's Applications for Payment.
52. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by Contractor's Team and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
53. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed. The Site includes rights-of-way, easements, and other lands or areas furnished by Owner which are designated for use by the Contractor.
54. *Specifications*—The part of the Contract that describes the requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
55. *Subcontractor*—An individual or entity having a direct contract with Contractor or with other Subcontractors or Suppliers for the performance of a part of the Work.
56. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Construction Manager, or that is indicated as a Submittal in the Schedule of Documents accepted by Construction Manager. Submittals, whether approved or accepted by OPT, are not Contract Documents.
57. *Substantial Completion*—The point where the Work or a specified part of the Work is sufficiently complete to be used for its intended purpose in accordance with the Contract Documents.
58. *Successful Offeror*—The Offeror to which Owner awards the Contract.
59. *Supplementary Conditions*—The part of the Contract that amends or supplements the General Conditions.
60. *Supplier*—A Manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with Subcontractors or other Suppliers to furnish materials or equipment to be incorporated in the Work.

61. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions with respect to either:
 - a. Existing subsurface conditions at or adjacent to the Site;
 - b. Existing physical conditions at or adjacent to the Site including existing surface or subsurface structures at the Site, except Underground Facilities; or
 - c. Hazardous Environmental Conditions at the Site.
62. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site , including those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
63. *Unit Price Work*—Work to be paid for based on unit prices.
64. *Work*—The construction of the Project or its component parts as required by the Contract Documents.
65. *Work Change Directive*—A directive issued to Contractor on or after the Effective Date of the Contract ordering an addition, deletion, or revision in the Work. The Work Change Directive serves as a memorandum of understanding regarding the directive until a Change Order can be issued.

1.02 Terminology

- A. The words and terms discussed in this Paragraph 1.02 are not defined terms that require initial capital letters, but when used in the Bidding Requirements or Proposal Requirements, or the Contract Documents, have the indicated meaning.
- B. Contract Documents are written using imperative language:
 1. Simple imperative sentence structure is used which places a verb as the first word in the sentence. It is understood that the words “furnish,” “install,” “perform,” “provide,” or similar words include the meaning of the phrase “The Contractor shall...” before these words.
 2. Unless specifically stated that action is to be taken by the OPT or others, it is understood that the action described is a requirement of the Contractor.
- C. The use of the words “furnish,” “install,” “perform,” and “provide” have the following meanings when used relating to services, materials, or equipment:
 1. Furnish means to supply and deliver the specified services, materials, or equipment to the Site or other specified location ready for use or installation.
 2. Install means to complete construction or assembly of the specified services, materials, or equipment so they are ready for their intended use.
 3. Perform or provide means to furnish and install specified services, materials, or equipment, complete and ready for their intended use.

4. Perform or provide the specified services, materials, or equipment complete and ready for intended use if the Contract Documents require specific services, materials, or equipment, but do not expressly use the words “furnish,” “install,” “perform,” or “provide.”
- D. The meaning and intent of certain terms or adjectives are described as follows:
1. The terms “as allowed,” “as approved,” “as ordered,” “as directed,” or similar terms in the Contract Documents indicate an exercise of professional judgment by the OPT.
 2. Adjectives like “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or similar adjectives are used to describe a determination of OPT regarding the Work.
 3. Any exercise of professional judgment by the OPT will be made solely to evaluate the Work for general compliance with the Contract Documents unless there is a specific statement in the Contract Documents indicating otherwise.
 4. The use of these or similar terms or adjectives does not assign a duty or give OPT authority to supervise or direct the performance of the Work, or assign a duty or give authority to the OPT to undertake responsibilities contrary to the provisions of Article 9, Article 10, or other provisions of the Contract Documents.
- E. Requirements apply to all Work of the same kind, class, and type even though the word “all” or “any” is not stated.
- F. The terms “includes” and “including” are used as terms of enlargement and not of limitation or exclusive enumeration and use of these terms does not create a presumption that components not expressed are excluded. The terms “consist of” or “consisting of” limits the interpretation to only those items specifically listed.
- G. It is understood that the cost of providing Work is included in the Contract Price and no additional compensation is to be paid by Owner unless specifically stated otherwise in the Contract Documents. Expressions like “at no additional cost to Owner,” “at Contractor’s expense,” or similar words mean that the Contractor is to include the cost of this Work in their Contract Price and perform or provide specified Work without an increase in the Contract Price.
- H. Words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with this recognized meaning unless stated otherwise in the Contract Documents.
- I. Written documents are required where reference is made to notices, reports, approvals, consents, statements, instructions, opinions, or other types of documentation or communications required by the Contract Documents. Approval and consent documents must be received by Contractor prior to the action or decision for which approval or consent is given. These may be made in printed or electronic format through the OPT’s Project Management Information System or other electronic media as required by the Contract Documents or approved by the Construction Manager.
- J. Giving notice as required by the Contract Documents may be by printed or electronic media using a method that requires acknowledgment of the receipt of that notice.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

- A. Provide required bonds and evidence of insurance required by the Contract Documents to Construction Manager with the executed Agreement.

2.02 Copies of Documents

- A. OPT will furnish one copy of the executed Contract Documents in electronic portable document format (PDF). This document is the Project Record Copy of the Contract Documents.

2.03 Before Starting Construction

- A. Provide the following preliminary documents in accordance with the Contract Documents within 10 days after the Effective Date of the Contract:
 - 1. Progress Schedule;
 - 2. Schedule of Documents;
 - 3. Schedule of Values; and
 - 4. Schedule of Anticipated Payments.
- B. Designate the specific individuals authorized to act as representatives of the Contractor. These individuals must have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of the Contractor.
- C. Owner will designate the specific individuals authorized to act as representatives of the Owner and the limits of their authority regarding acting on behalf of the Owner.

2.04 Electronic Transmittals

- A. Except as otherwise stated elsewhere in the Contract Documents, the OPT and Contractor will send and accept Electronic Documents sent by Electronic Means using protocols provided by or acceptable to the OPT.
- B. The contents of the information in any Electronic Document will be the responsibility of the transmitting party. Electronic Documents may be used in the same manner as the printed versions of the same documents that are exchanged using non-electronic format and methods, and are subject to the same governing requirements, limitations, and restrictions, set forth in the Contract Documents.
- C. Provisions of this Contract regarding Electronic Documents must be incorporated into other agreements or subcontracts on the Project. Nothing in this paragraph reduces or eliminates requirements:
 - 1. to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations;
 - 2. to comply with any applicable Law or Regulation governing the signing and sealing of design documents and related Modifications or the signing and electronic transmission of any other documents; or

3. to comply with the notice requirements.
- D. When sending Electronic Documents by Electronic Means the sending party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or sending Electronic Documents.
- E. System Infrastructure for Electronic Document Exchange (EDP):
1. Contractor will provide hardware, operating system(s) software, internet, e-mail, and large file transfer functions ("System Infrastructure") at its own cost. System Infrastructure must comply with these requirements.
 2. The maximum size of an email attachment for exchange of Electronic Documents under this EDP is 100 MB. Attachments larger than that may be exchanged in parts or by using large file transfer functions or physical media.
 3. Contractor assumes full and complete responsibility for its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, or otherwise enabling its System Infrastructure, including operating systems and software.
 4. Contractor is responsible for its own system operations, security, back-up, archiving, audits, printing resources, and other Information Technology ("IT") for maintaining operations of its System Infrastructure during the Project, including coordination with individual(s) or entity responsible for managing its System Infrastructure and capable of addressing routine communications and other IT issues affecting the exchange of Electronic Documents.
 5. Contractor will operate and maintain industry-standard, industry-accepted, ISO standard, commercial-grade security software and systems that are intended to protect others from: software viruses and other malicious software like worms, trojans, adware; data breaches; loss of confidentiality; and other threats in the transmission to or storage of information from the other parties, including transmission of Electronic Documents by physical media such as CD/DVD/flash drive/hard drive. Contractor will not be liable to others for any breach of system security to the extent that Contractor maintains and operates required security software and systems.
 6. In the case of disputes, conflicts, or modifications to the use of Electronic Documents required to address issues affecting System Infrastructure, Contractor and OPT will cooperatively resolve the issues; but, failing resolution, the OPT is authorized to make and require reasonable and necessary changes meet its original intent. Contractor may submit a Change Proposal if the changes cause additional cost or time to Contractor that could not have reasonably been anticipated.
 7. Contractor and OPT are both responsible for their own back-up and archive of documents sent and received during the term of the contract. Contractor and OPT remain solely responsible for its own post-Project back-up and archive of Project documents after the term of the Contract as each party deems necessary for its own purposes.

8. If a Contractor or OPT receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving party will advise the sending party of the incomplete transmission. The parties will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the communication.
 9. The OPT will operate a project information management system (Project Website) for use of OPT and Contractor during the Project for exchange and storage of Project-related communications and information. Except as otherwise provided in this Contract, use of the Project Website will be mandatory for exchange of Project documents, communications, submittals, and other Project-related information.
- F. Software Security: The parties agree not to intentionally edit, reverse engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes any Electronic Document or information contained therein that was transmitted in a software data format, including Portable Document Format (PDF), intended by sender not to be modified, unless the receiving party obtains the permission of the sending party or is citing or quoting excerpts of the Electronic Document for Project purposes.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 Intent

- A. Requirements of each part of the Contract Documents are as binding as if required by all Contract Documents. It is the intent of the Contract Documents to describe a functionally complete project. The Contract Documents do not indicate or describe all the Work required to complete the Project. Additional details required for construction of the Project are to be provided by the Contractor and coordinated with the OPT.
- B. Provide the labor, documentation, services, materials, or equipment that may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result, whether specifically called for in the Contract Documents or not. Include these related costs in the offered Contract Price.
- C. Provide equipment that is functionally complete as described in the Contract Documents. The Drawings and Specifications do not indicate or describe all the Work required to complete the installation of equipment purchased by the Owner or Contractor. Additional details required for the correct installation of selected equipment are to be provided by the Contractor and coordinated with the Design Professional through the Construction Manager.
- D. Comply with the most stringent requirements where compliance with two or more standards is specified and they establish different or conflicting requirements for the Work, unless the Contract Documents indicate otherwise.
- E. Provide materials and equipment comparable in quality to similar materials and equipment incorporated in the Project or as required to meet the minimum requirements of the application if the materials and equipment are shown in the Drawings but are not included in the Specifications.
- F. The Project Record Copy of the Contract Documents governs if there is a discrepancy between the Project Record Copy of the Contract Documents and subsequent electronic or

digital versions of the Contract Documents, including printed copies derived from these electronic or digital versions.

- G. The Contract supersedes all prior written or oral negotiations, representations, and agreements. The Contract Documents comprise the entire Agreement between Owner and Contractor. The Contract Documents may be modified only by a Modification.
- H. Request clarification from Construction Manager for a decision before proceeding if Contractor is not clear on the meaning of the Contract Documents. Construction Manager is to issue clarifications and interpretations of the Contract Documents in accordance with the Contract Documents.
- I. Organization of the Documents:
 - 1. Organization of the Contract Documents is not intended to control or lessen the responsibility of the Contractor when dividing Work among Subcontractors or Suppliers, or to establish the extent of Work to be performed by trades, Subcontractors, or Suppliers, except on multi-prime contracts. Specifications or details do not need to be indicated or specified in each Specification or Drawing. Items shown in the Contract Documents are applicable regardless of their location in the Contract Documents.
 - 2. Standard paragraph titles and other identifications of subject matter in the Specifications are intended to aid in locating and recognizing various requirements of the Specifications. Titles do not define, limit, or otherwise restrict Specification text.
 - 3. The Contract requirements described in the General Conditions, Supplementary Conditions, and General Requirements (Division 01 Sections of the Specifications) apply to Work regardless of where it is described in the Contract Documents, unless specifically noted otherwise.
 - 4. Specifications or details do not need to be indicated or specified in each Specification or Drawing. Items shown in the Contract Documents are applicable regardless of their location in the Contract Documents.
- J. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- K. Nothing in the Contract Documents creates:
 - 1. a contractual relationship between OPT and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. an obligation on the part of OPT to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 Reference Standards

A. Standard Specifications, Codes, Laws and Regulations:

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of technical societies, organizations, or associations, or to Laws or Regulations, whether specific or implied, are those in effect at the time Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price unless specifically stated otherwise in the Contract Documents.
2. No provision of referenced standard specifications, manuals, reference standards, codes, or instructions of a Supplier changes the duties or responsibilities of OPT or Contractor from those described in the Contract Documents or assigns a duty to or gives authority to the OPT to supervise or direct the performance of the Work or undertake responsibilities inconsistent with the Contract Documents.
3. The provisions of the Contract Documents take precedence over standard specifications, manuals, reference standards, codes, or instructions of a Supplier unless specifically stated otherwise in the Contract Documents.

B. Comply with applicable construction industry standards, whether referenced or not.

1. Standards referenced in the Contract Documents govern over standards not referenced but recognized as applicable in the construction industry.
2. Comply with the requirements of the Contract Documents if they produce a higher quality of Work than the applicable construction industry standards.
3. Submit questions regarding which code or standard is applicable to the Construction Manager. Design Professional will determine whether a code or standard is applicable, which of several codes or standards are applicable, or if the Contract Documents produce a higher quality of Work. Construction Manager will respond to the question as appropriate.

C. Make copies of reference standards available if requested by Construction Manager.

3.03 Reporting and Resolving Discrepancies

A. Reporting Discrepancies:

1. Carefully study the Drawings and verify pertinent figures and dimensions with respect to actual field measurements before undertaking the Work. Immediately report conflicts, errors, ambiguities, or discrepancies that Contractor discovers or has actual knowledge of to the Construction Manager.
2. Immediately notify the Construction Manager of conflicts, errors, ambiguities, or discrepancies in the Contract Documents or discrepancies between the Contract Documents and:
 - a. Applicable Laws or Regulations;
 - b. Actual field conditions;
 - c. Standard specifications, manuals, reference standards, or codes; or
 - d. Instructions of Suppliers.

3. Do not proceed with affected Work until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation from the Construction Manager or by a Modification to the Contract Documents issued pursuant to Paragraph 11.01, except in an emergency as required by Paragraph 7.12.
4. Contractor is liable to the OPT for failure to report conflicts, errors, ambiguities, or discrepancies in the Contract Documents of which Contractor has actual knowledge.
5. Contractor is deemed to have included the most expensive item, system, procedure, etc. in the Contract Price if a conflict, error, ambiguity, or discrepancy in the Contract Documents was known, but not reported prior to submitting the Bid or Proposal or when Contractor negotiates the Contract Price.

3.04 Interpretation of the Contract Documents

- A. Submit questions concerning the non-technical or contractual/administrative requirements of the Contract Documents to the Construction Manager immediately after the question arises. Construction Manager will provide an interpretation of the Contract Documents regarding these questions and will coordinate the response of the OPT to Contractor.
- B. Submit questions regarding the design of the Project described in the Contract Documents to the Construction Manager immediately after the question arises. Construction Manager will request an interpretation of the Contract Documents from the Design Professional. Construction Manager will coordinate the response of the OPT to Contractor.
- C. OPT may initiate a Modification to the Contract Documents through the Construction Manager if a response to the question indicates that a change in the Contract Documents is required. Contractor may appeal Design Professional's or Construction Manager's interpretation by submitting a Change Proposal.

3.05 Reuse of Documents

- A. Contractor's Team has no rights to the Contract Documents and may not use the Contract Documents or copies or electronic media editions of the Contract Documents other than for the construction of this Project. This provision survives final payment or termination of the Contract.
- B. Contractor can retain a copy of the Contract Documents for record purposes, unless specifically prohibited by the Owner for security reasons. Surrender paper and digital copies of the Contract Documents and other related documents and remove these documents from computer equipment or storage devices as a condition of final payment if the Owner so directs.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 Commencement of Contract Times; Notice to Proceed

- A. The Contract Times commence to run on the date indicated in the Notice to Proceed. If a Notice to Proceed is not issued, the Contract Times will commence to run 15 days after the Contract is signed by all parties.

- B. Begin performing the Work on the date indicated in the Notice to Proceed. Do not begin Work before the date indicated in the Notice to Proceed or prior to providing evidence that insurance required by the Contract is in effect.

4.02 Progress Schedule

- A. Construct the Work in accordance with the Progress Schedule established in accordance with the Contract Documents.
 - 1. Adjust the Progress Schedule as required to accurately reflect actual progress on the Work.
 - 2. Submit proposed adjustments in the Progress Schedule that change the Contract Times in accordance with the requirements of Article 11.
- B. Continue performing Work and adhere to the Progress Schedule during disputes or disagreements with Owner. Do not delay or postpone Work pending resolution of disputes or disagreements, or during an appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree.

4.03 Delays in Contractor's Progress

- A. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delays, disruptions, or interference caused by or within the control of Contractor's Team.
- B. Contractor is entitled to an equitable adjustment in Contract Price or Contract Times if OPT directly delays, disrupts, or interferes with the performance or progress of the Work. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of the Owner if this delay is concurrent with a delay, disruption, or interference attributable to or within the control of the Contractor's Team.
- C. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of OPT or Contractor. These adjustments in Contract Times are the Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. These unanticipated causes include:
 - 1. Severe and unavoidable natural catastrophes e.g. fires, floods, epidemics, and earthquakes;
 - 2. Acts of war or terrorism;
 - 3. Acts or failures to act of utility owners or other third-party entities other than those third-party utility owners performing other work at or adjacent to the Site as arranged by the Owner and, as contemplated in Article 8;
 - 4. The existence of a differing subsurface or physical condition;
 - 5. An Underground Facility not shown or not indicated with reasonable accuracy by the Contract Documents;
 - 6. Hazardous Environmental Conditions; and

7. Delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site unless this other work also for the Owner.
- D. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed or disrupted by weather conditions provided such weather conditions exceed those that could normally be expected for the Site in that month of the year, unless other provisions for Weather related delays are included in the Contract Documents. Contractor is to include time associated with normal weather-related delays in the Project Schedule and assumes the risks, including costs, associated with delays related to normal weather conditions.
- E. Contractor is only entitled to an adjustment of the Contract Times for specific delays, disruptions, and interference to the performance or progress of the Work that can be demonstrated to directly impact the ability of the Contractor to complete the Work within the Contract Times. No adjustments in Contract Times are allowed for delays on components of the Work which were or could have been completed without impacting the Contract Times.
- F. Notify the Construction Manager immediately of a potential delaying, disrupting, or interfering event. Submit a Change Proposal seeking an adjustment in Contract Price or Contract Times within 30 days of the commencement of the delaying, disrupting, or interfering event. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11. Change Proposals seeking an increase in Contract Times or Contract Price submitted must include supporting data that details the following:
 1. The circumstances that form the basis for the requested adjustment;
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference;
 5. A revised Progress Schedule indicating all the activities affected by the delay, disruption, or interference;
 6. An explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work;
 7. The impact on Contract Price, in accord with the provisions of Paragraph 11.07; and
 8. Such additional supporting documentation as OPT may require.

ARTICLE 5 – SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 Availability of Lands

- A. Owner will furnish the Site and inform the Contractor of encumbrances or restrictions known to Owner related to use of the Site with which Contractor must comply in performing the Work.
- B. Provide for additional lands and access Contractor requires for temporary construction facilities or storage of materials and equipment, other than those identified in the Contract Documents. Provide documentation of authority to use these additional lands to Construction Manager before using them.

5.02 Use of Site and Other Areas

- A. Confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Owner or Contractor has arranged to use through construction easements or agreements, and other adjacent areas as permitted by Laws and Regulations. Assume full responsibility for damage or injuries which result from the performance of the Work or from other actions or conduct of the Contractor's Team, including:
 - 1. Damage to the Site;
 - 2. Damage to adjacent areas used for Contractor's Team's operations;
 - 3. Damage to other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and
 - 4. Injuries and losses sustained by the owners or occupants of these lands or areas.
- B. Take the following action if a damage or injury claim is made by the owner or occupant of adjacent land or area because of the performance of the Work, or because of other actions or conduct of the Contractor's Team:
 - 1. Take immediate corrective or remedial action as required by Paragraph 7.09; and
 - 2. Attempt to settle the claim through negotiations with the owner or occupant, or otherwise resolve the claim by mediation or other dispute resolution proceeding or at law; and
 - 3. TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ANY SUCH CLAIM AND ALL INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO ANY CLAIM OR ACTION BROUGHT BY ANY SUCH OWNER OR OCCUPANT AGAINST OWNER'S INDEMNITEES TO THE EXTENT CAUSED DIRECTLY OR INDIRECTLY, IN WHOLE OR IN PART BY, OR BASED UPON, CONTRACTOR'S PERFORMANCE OF THE WORK, OR BECAUSE OF OTHER ACTIONS OR CONDUCT OF THE CONTRACTOR'S TEAM.

5.03 Subsurface and Physical Conditions

- A. The Supplementary Conditions identify:
 - 1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data; and
 - 2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site, except Underground Facilities, that contain Technical Data.
 - 3. Technical Data contained in these reports and drawings.
- B. If no Technical Data have been identified in the Supplementary Conditions, then Technical Data is defined, with respect to conditions at the Site, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, or environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
- C. Information and data regarding the presence or location of Underground Facilities is not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.
- D. Contractor may rely upon the accuracy of the Technical Data contained in these reports and drawings, but these reports and drawings are not Contract Documents. Except for this reliance on Technical Data, Contractor may not rely upon or make claims against Owner's Indemnitees with respect to:
 - 1. The completeness of reports and drawings for Contractor's purposes, including aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, or Contractor's safety precautions and programs; or
 - 2. Other data, interpretations, opinions, and information contained in these reports or shown or indicated in the drawings; or
 - 3. The contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
 - 4. Contractor's interpretation of or conclusions drawn from Technical Data or other data, interpretations, opinions, or information.

5.04 Differing Subsurface or Physical Conditions

- A. Notify Construction Manager immediately, but in no event later than 3 days, after becoming aware of a subsurface or physical condition that is uncovered or revealed at the Site, and before further disturbing the subsurface or physical conditions or performing any related Work that:
 - 1. Establishes that the Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
 - 2. Requires a change in the Drawings or Specifications;

3. Differs materially from that shown or indicated in the Contract Documents; or
 4. Is of an unusual nature and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents.
- B. Do not further disturb or perform Work related to this subsurface or physical condition, except in an emergency as required by Paragraph 7.12, until permission to do so is issued by Construction Manager.
- C. Construction Manager is to notify the OPT after receiving notice of a differing subsurface or physical condition from the Contractor. OPT will:
1. Promptly review the subsurface or physical condition;
 2. Determine the necessity of OPT's obtaining additional exploration or tests with respect to the subsurface or physical condition;
 3. Determine if the subsurface or physical condition falls within one or more of the differing site condition categories in Paragraph 5.04.A;
 4. Prepare recommendations regarding the Contractor's resumption of Work relating to the subsurface or physical condition in question;
 5. Determine the need for changes in the Drawings or Specifications; and
 6. Advise Contractor of OPT's findings, conclusions, and recommendations.
- D. Construction Manager is to issue a statement to Contractor regarding the subsurface or physical condition in question and recommend action as appropriate after review of OPT's findings, conclusions, and recommendations. Construction Manager may instruct Contractor to resume Work if OPT determines that the subsurface or physical condition in question has been adequately documented.
- E. Contractor is entitled to an equitable adjustment in Contract Price or Contract Times to the extent that a differing subsurface or physical condition causes a change in Contractor's cost or time to perform the Work provided the condition falls within one or more of the categories described in Paragraph 5.04.A. Any adjustment in Contract Price for Work that is paid for on a unit price basis is subject to the provisions of Paragraph 13.03. Contractor is not entitled to an adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
1. Contractor knew of the existence of the subsurface or physical condition at the time Contractor made an offer to Owner with respect to Contract Price and Contract Times;
 2. The existence of the subsurface or physical condition could have been discovered or revealed by examinations, investigations, explorations, tests, or studies of the Site and contiguous areas expressly required by the Bidding Requirements or Proposal Requirements or the Contract Documents prior to when Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price; or
 3. Contractor failed to give notice as required by Paragraph 5.04.A.
- F. Contractor may submit a Change Proposal no later than 30 days after Construction Manager's issuance of the OPT's statement to Contractor regarding the subsurface or physical condition in question.

5.05 Underground Facilities

- A. The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to OPT by the owners of these Underground Facilities or by others. OPT is not responsible for the accuracy or completeness of information or data provided by others that OPT makes available to Contractor. The Contractor is responsible for:
 - 1. Reviewing and checking available information and data regarding existing Underground Facilities at the Site;
 - 2. Complying with Laws and Regulations related to locating Underground Facilities before beginning Work;
 - 3. Locating Underground Facilities shown or indicated in the Contract Documents;
 - 4. Coordinating the Work with the owners, including Owner, of Underground Facilities during construction; and
 - 5. The safety and protection of existing Underground Facilities at or adjacent to the Site and repairing damage resulting from the Work.
- B. Notify the Construction Manager and the owner of the Underground Facility immediately if an Underground Facility is uncovered or revealed at the Site that was not shown in the Contract Documents or was not shown with reasonable accuracy in the Contract Documents. Do not further disturb conditions or perform Work affected by this discovery, except in the event of an emergency as required by Paragraph 7.12.
- C. The OPT is to take the following action after receiving notice from the Construction Manager:
 - 1. Promptly review the Underground Facility to determine if the Underground Facility was shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy;
 - 2. Identify and communicate with the owner of the Underground Facility;
 - 3. Prepare recommendations to OPT regarding the Contractor's resumption of Work relating to this Underground Facility;
 - 4. Determine the extent to which a change is required in the Drawings or Specifications to document the consequences of the existence or location of the Underground Facility; and
 - 5. Construction Manager will advise Contractor of OPT's findings, conclusions, and recommendations and provide revised Drawings and Specifications if required.
- D. Construction Manager is to issue a statement to Contractor regarding the Underground Facility in question and recommend action as appropriate after review of OPT's findings, conclusions, and recommendations.
- E. Contractor is entitled to an equitable adjustment in the Contract Price or Contract Times as provided in Paragraphs 11.04 and 11.05 to the extent that the existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy. Any adjustment in Contract Price for Work that is paid for on a unit price basis is subject to the provisions of Paragraph 13.03.

- F. Contractor is not entitled an adjustment in the Contract Price or Contract Times with respect to an existing Underground Facility at the Site if:
 - 1. Contractor knew of the existence of the existing Underground Facility at the Site at the time Contractor made an offer to Owner with respect to Contract Price and Contract Times;
 - 2. The existence of the existing Underground Facility at the Site could have been discovered or revealed by examinations, investigations, explorations, tests, or studies of the Site and contiguous areas expressly required by the Bidding Requirements or Proposal Requirements or the Contract Documents prior to when Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price; or
 - 3. Contractor failed to give notice as required by Paragraph 5.05.B.
- G. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of adjustments in the Contract Price or Contract Times no later than 30 days after Construction Manager's issuance of OPT's statement to Contractor regarding the Underground Facility.

5.06 Hazardous Environmental Conditions at Site

- A. The Supplementary Conditions identify those reports and drawings known to OPT relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and the Technical Data contained in these reports and drawings.
- B. Contractor may rely upon the accuracy of the Technical Data contained in reports and drawings relating to Hazardous Environmental Conditions identified in the Supplementary Conditions, but these reports and drawings are not Contract Documents. Except for the reliance on expressly identified Technical Data, Contractor may not rely upon or make claims against Owner's Indemnitees with respect to:
 - 1. The completeness of these reports and drawings for Contractor's purposes, including aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor or Contractor's safety precautions and programs related to Hazardous Environmental Conditions;
 - 2. Other data, interpretations, opinions, and information contained in these reports or shown or indicated in the drawings; or
 - 3. Any Contractor interpretation of or conclusion drawn from Technical Data or other data, interpretations, opinions, or information.
- C. The results of tests performed on materials described in environmental reports specifically prepared for the Project and made available to Contractor are defined as Technical Data unless Technical Data has been defined more specifically in the Supplementary Conditions.
- D. Contractor is not responsible for removing or remediating Hazardous Environmental Conditions encountered, uncovered, or revealed at the Site unless this removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

- E. Contractor is responsible for controlling, containing, and duly removing and remediating Constituents of Concern brought to the Site by Contractor's Team and paying associated costs.
1. Owner may remove and remediate the Hazardous Environmental Condition and impose a set-off against payments to Contractor for associated costs if Contractor's Team creates a Hazardous Environmental Condition and Contractor does not take acceptable action to remove and remediate the Hazardous Environmental Condition.
 2. TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE FAILURE TO CONTROL, CONTAIN, OR REMOVE A CONSTITUENT OF CONCERN BROUGHT TO THE SITE BY CONTRACTOR'S TEAM, OR TO A HAZARDOUS ENVIRONMENTAL CONDITION CREATED BY CONTRACTOR'S TEAM. NOTHING IN THIS PARAGRAPH SHALL OBLIGATE CONTRACTOR TO INDEMNIFY ANY INDIVIDUAL OR ENTITY FROM AND AGAINST THE CONSEQUENCES OF THAT INDIVIDUAL'S OR ENTITY'S OWN NEGLIGENCE.
- F. Immediately notify the Construction Manager and take the following action if Contractor uncovers or reveals a Hazardous Environmental Condition at the Site or adjacent areas used by the Contractor's Team that was not created by the Contractor's Team:
1. Secure or otherwise isolate this condition;
 2. Stop Work in affected areas or connected with the condition, except in an emergency as required by Paragraph 7.12; and
 3. Do not resume Work relating to the Hazardous Environmental Condition or in affected areas until after OPT has obtained required permits and Construction Manager sends notice to the Contractor:
 - a. Specifying that this condition and affected areas are or have been rendered safe for the resumption of Work; or
 - b. Specifying special conditions under which Work may be resumed safely.
 4. Owner may order the portion of the Work that is in the area affected by the Hazardous Environmental Condition to be deleted from the Work following the procedures in Article 11 if Contractor does not agree to:
 - a. Resume the Work based on a reasonable belief it is unsafe; or
 - b. Resume the Work under the special conditions provided by the Construction Manager.
 5. Owner may have this deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.
- G. Contractor may submit a Change Proposal or Owner may impose a set-off if an agreement is not reached within 10 days of Construction Manager's notice regarding the resumption of Work as to whether Contractor is entitled to an adjustment in Contract Price or Contract Times or on the amount or extent of adjustments resulting from this Work stoppage or special conditions under which Contractor agrees to resume Work.

- H. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6 – BONDS AND INSURANCE

6.01 Performance, Payment, and Other Bonds

- A. Furnish a performance bond in an amount equal to the Contract Price as security for the faithful performance of Work. Contractor is to use amounts paid by Owner to Contractor under the Contract for the performance of the Contract. This bond is to remain in effect until 1 year after the date of final payment.
- B. Furnish a payment bond in an amount equal to the Contract Price as security to ensure payment of Contractor's obligations under the Contract Documents. This bond is to remain in effect until 1 year after the date of final payment.
 - 1. Notify the Construction Manager of claims filed against the payment bond. Notify the claimant and Construction Manager of undisputed amounts and the basis for challenging disputed amounts when a claimant has satisfied the conditions prescribed by Laws and Regulations. Promptly pay undisputed amounts.
 - 2. Owner is not liable for payment of costs or expenses of claimants under the payment bond. Owner has no obligations to pay, give notice, or take other action to claimants under the payment bond.
 - 3. OPT will provide a copy of the payment bond and payment information to Subcontractors, Suppliers, or other persons or entities claiming to have furnished labor or materials used in the performance of the Work that request this information in accordance with Laws and Regulations.
- C. Notify Construction Manager immediately if the surety on bonds furnished by Contractor:
 - 1. Is declared bankrupt, or becomes insolvent;
 - 2. Has its right to do business in state in which the Project is located is terminated; or
 - 3. Ceases to meet the requirements of Paragraph 6.02.

Provide a bond and surety which comply with the requirements of Paragraph 6.02 within 20 days after the event giving rise to this notification.
- D. Furnish other bonds as required by the Contract Documents.
- E. Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16 if Contractor fails to obtain or maintain the required bonds.

6.02 Licensed Sureties

- A. Provide bonds in the form prescribed by the Contract Documents from sureties named in the U.S. Department of the Treasury's Listing of Approved Sureties (Department Circular 570 "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies").

- B. Provide bonds required by the Contract Documents from surety companies that are duly licensed or authorized to provide bonds in the state in which the Project is constructed.

6.03 Insurance

- A. Obtain and maintain insurance in accordance with Section 00 73 16 "Insurance Requirements."

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

7.01 Contractor's Means and Methods of Construction

- A. Contractor is solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. Provide professional engineering or other design services if the Contract Documents require such services or if Contractor determines that such services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety. Engineering or other design services are to be provided by a properly licensed design professional authorized to provide these services in the state in which the Project is constructed. Such services are not Owner-delegated professional design services under this Contract, and OPT does not have any responsibility with respect to:
 - 1. Contractor's determination of the need for such services;
 - 2. The qualifications or licensing of the design professionals retained or employed by Contractor;
 - 3. The performance of such services; or
 - 4. Any errors, omissions, or defects in such services.

7.02 Supervision and Superintendence

- A. Supervise, inspect, and direct the performance of the Work.
- B. Provide a competent resident superintendent acceptable to the OPT. The resident superintendent or acceptable qualified assistant shall always be present when Work is being done. Cease Work at any time the resident superintendent or acceptable qualified assistant is not on site. Contract is responsible for delays related to stoppage of Work due to the absence of the resident superintendent or acceptable qualified assistant.
- C. Do not replace this resident superintendent except under extraordinary circumstances. Provide a replacement resident superintendent equally competent to the previous resident superintendent if replacement is required. Notify the Owner prior to replacing the resident superintendent and obtain Owner's consent to the change in superintendent.

7.03 Labor; Working Hours

- A. Provide competent, suitably qualified personnel to complete the Work. Maintain good discipline and order at the Site. Contractor is responsible for all acts and omissions of Contractor's Team.

- B. Perform Work at the Site during regular working hours except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent to the Site and except as otherwise stated in the Contract Documents.
- C. Do not perform Work on a Saturday, Sunday, or Owner-observed holiday without the Construction Manager's consent. If a legal holiday falls on a Saturday, it will be observed the preceding Friday. If a legal holiday falls on a Sunday, it will be observed the following Monday.
- D. Pay additional cost incurred by Owner for services of the Construction Manager to observe Work constructed outside of regular working hours. Construction Manager will issue a set-off in the Application for Payment for this cost per Paragraph 15.01.B.

7.04 Services, Materials, and Equipment

- A. Provide services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and other facilities and incidentals necessary for the performance, testing, startup, and completion of the Work, whether or not these items are specifically called for in the Contract Documents.
- B. Provide new materials and equipment to be incorporated into the Work. Provide special warranties and guarantees required by the Contract Document. Provide satisfactory evidence, including reports of required tests, as to the source, kind, and quality of materials and equipment as required by the Contract Documents or as requested by the Construction Manager.
- C. Store, apply, install, connect, erect, protect, use, clean, and condition materials and equipment in accordance with instructions of the applicable Supplier, unless otherwise required by the Contract Documents.

7.05 Concerning Subcontractors and Suppliers

- A. Contractor may retain Subcontractors and Suppliers which are acceptable to Owner for the performance of parts of the Work. Contractor must retain specific Subcontractors or Suppliers if required to do so by the Contract Documents. Contractor must use Subcontractors or Suppliers named in the Bid or Proposal if Contractor was selected in part based on these named Subcontractors or Suppliers.
- B. Submit a list of proposed Subcontractors and Suppliers to Construction Manager prior to entering into binding subcontracts or purchase orders. These proposed Subcontractors or Suppliers are deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 10 days after receiving this list.
- C. Owner may require the replacement of Subcontractors or Suppliers retained by the Contractor. Provide an acceptable replacement for the rejected Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements, subject to Contractor's reasonable objections.
- D. Contractor may be entitled to an adjustment in Contract Price or Contract Times with respect to a replacement of Subcontractors or Suppliers required by Owner. Notify Construction Manager immediately if a replacement of Subcontractors or Suppliers increases the Contract Price or Contract Times. Initiate a Change Proposal for the

adjustment within 10 days of Owner's notice to replace a Subcontractor or Supplier. Do not make the replacement until the change in Contract Price or Contract Times has been accepted by the Owner if Change Proposal is to be submitted. The Contractor is not entitled to an adjustment in Contract Price or Contract Times if OPT requires the replacement of the Subcontractor or Supplier based on an unacceptable safety record, lack of experience or qualifications, or other cause.

- E. Acceptance by Owner of Subcontractors, Suppliers, or other individuals or entities, whether initially or as a replacement, does not constitute a waiver of the obligation of the Contractor to complete the Work in accordance with the Contract Documents.
- F. Maintain a current and complete list of Subcontractors and Suppliers that are to perform or furnish part of the Work.
- G. Contractor is fully responsible for the acts and omissions of Subcontractors and Suppliers and is solely responsible for scheduling and coordinating their Work.
- H. Require Subcontractors, Suppliers, and other individuals or entities performing or furnishing Work to communicate with OPT through Contractor.
- I. Contracts between the Contractor and their Subcontractors or Suppliers may specifically bind the Subcontractors or Suppliers to the applicable terms and conditions of the Contract Documents. Contractor is responsible for meeting the requirements of the Contract Documents if they choose to not bind the Subcontractors or Suppliers to applicable terms or conditions of the Contract Documents.
- J. OPT may furnish information about amounts paid to Contractor for Work provided by Subcontractors or Suppliers to the entity providing the Work.
- K. Nothing in the Contract Documents:
 - 1. Creates a contractual relationship between members of the OPT and members of the Contractor's Team.
 - 2. Creates an obligation on the part of the Owner to pay or to see to the payment of money due members of the Contractor's Team, except as may be required by Laws and Regulations.

7.06 Patent Fees and Royalties

- A. Pay license fees, royalties, and costs incident to the use of inventions, designs, processes, products, or devices which are patented or copyrighted by others in the performance of the Work, or to incorporate these inventions, designs, processes, products, or devices which are patented or copyrighted by others in the Work. The Contract Documents identify inventions, designs, processes, products, or devices OPT knows are patented or copyrighted by others, or that its use is subject to patent rights or copyrights calling for the payment of a license fee or royalty to others. Contractor is to include the cost associated with the use of patented or copyrighted products or processes, whether specified or selected by the Contractor, in the Contract Price.
- B. TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO ANY INFRINGEMENT OF PATENT RIGHTS OR COPYRIGHTS BY CONTRACTOR'S TEAM INCIDENT TO THE USE IN

THE PERFORMANCE OF THE WORK OR RESULTING FROM THE INCORPORATION IN THE WORK OF ANY INVENTION, DESIGN, PROCESS, PRODUCT, OR DEVICE.

7.07 Permits

- A. Obtain and pay for construction permits and licenses, and certificates of occupancy, if required. OPT is to assist Contractor in obtaining permits and licenses when required to do so by applicable Laws and Regulations. Pay governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time the Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price.

7.08 Taxes

- A. Contractor is responsible for all taxes and duties arising out of the Work. Contractor is responsible for including in the Contract Price any applicable sales and use taxes and is responsible for complying with all applicable Laws and Regulations. Pay sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations.

7.09 Laws and Regulations

- A. Give required notices and comply with Laws and Regulations applicable to the performance of the Work. OPT is not responsible for monitoring Contractor's compliance with Laws or Regulations except where expressly required by applicable Laws and Regulations.
- B. Pay costs resulting from actions taken by Contractor that are contrary to Laws or Regulations. Contractor is not responsible for determining that the design aspects of the Work described in the Contract Documents is in accordance with Laws and Regulations. This does not relieve Contractor of its obligations under Paragraph 3.03.
- C. TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM ALL CLAIMS AND INDEMNIFIED COSTS RESULTING FROM ACTIONS TAKEN BY CONTRACTOR'S TEAM THAT ARE CONTRARY TO LAWS OR REGULATIONS.
- D. Owner or Contractor may give notice to the other party of changes in Laws or Regulations that may affect the cost or time of performance of the Work, including:
 - 1. Changes in Laws or Regulations affecting procurement of permits; and
 - 2. Sales, use, value-added, consumption, and other similar taxes which come into effect after Contractor's Bid or Proposal is submitted or when Contractor negotiates the Contract Price.
- E. Contractor may submit a Change Proposal or Owner may initiate a Claim within 30 days of this notice if Owner and Contractor are unable to agree on entitlement to or on the amount or extent of adjustments in Contract Price or Contract Times resulting from these changes.

7.10 Safety and Protection

- A. Contractor is solely responsible for initiating, maintaining, and supervising safety precautions and programs relating to the Work. This responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the

performance of their Work, nor for compliance with applicable safety Laws and Regulations.

- B. Take necessary precautions for the safety of persons on the Site or who may be affected by the Work, and provide the necessary protection to prevent damage, injury, or loss to:
 - 1. Work and materials and equipment to be incorporated in the Work, whether stored on or off the Site; and
 - 2. Other property at or adjacent to the Site, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement during construction.
- C. Comply with applicable Laws and Regulations relating to the safety and protection of persons or property. Erect and maintain necessary safeguards for safety and protection. Notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site when prosecution of the Work may affect them. Cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
- D. Remedy damage, injury, or loss to property referred to in Paragraph 7.09.B caused by Contractor's Team. Pay remediation costs unless the damage or loss is:
 - 1. Attributable to the fault of the Contract Documents,
 - 2. Attributable to acts or omissions of OPT, or
 - 3. Not attributable to the actions or failure to act of the Contractor's Team.
- E. Contractor's duties and responsibilities for safety and protection of persons or the Work or property at or adjacent to the Site continues until Work is completed and resumes whenever Contractor's Team returns to the Site to fulfill warranty or correction obligations or to conduct other tasks.
- F. Comply with the applicable requirements of the Owner's safety program if required to do so in the Supplementary Conditions. A copy of the Owner's safety program will be provided in the Bidding Documents or Proposal Documents.
- G. Provide a qualified and experienced safety representative at the Site whose duties and responsibilities are the prevention of accidents and maintaining and supervising safety programs.

7.11 Hazard Communication Programs

- A. Coordinate the exchange of safety data sheets or other hazard communication information required to be made available or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.12 Emergencies

- A. Act to prevent threatened damage, injury, or loss in emergencies affecting the safety or protection of persons or the Work or property at or adjacent to the Site. Notify Construction Manager immediately if Contractor believes that significant changes in the Work or variations from the Contract Documents have been caused or are required because of this need to act. A Modification is to be issued by Construction Manager if OPT

determines that the incident giving rise to the emergency action was not the responsibility of the Contractor and that a change in the Contract Documents is required because of the action taken by Contractor in response to this emergency.

7.13 Contractor's General Warranty and Guarantee

- A. Contractor warrants and guarantees to Owner that Work is in accordance with the Contract Documents and is not Defective. Owner is entitled to rely on Contractor's warranty and guarantee. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 7.14. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.13 is limited only by applicable Laws and Regulations restricting actions to enforce such rights. Assume and bear responsibility for costs and time delays associated with variations from the requirements of the Contract Documents.
- B. Contractor's warranty and guarantee excludes defects or damage caused by abuse, improper maintenance or operation, or modification by OPT; or normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete Work in accordance with the Contract Documents is absolute. None of the following constitute an acceptance of Defective Work, a release of Contractor's obligation to perform Work in accordance with the Contract Documents, or a release of Owner's warranty or guarantee rights under this Paragraph 7.13:
 - 1. Observations by OPT;
 - 2. Recommendation by Construction Manager or payment by Owner of progress or final payments;
 - 3. The issuance of a certificate of Substantial Completion;
 - 4. The issuance of a certificate of Final Completion;
 - 5. The end of the correction period established in Paragraph 7.14;
 - 6. Use or occupancy of part of the Work by Owner;
 - 7. Review and approval of a Shop Drawing or Sample;
 - 8. Inspections, tests, or approvals by others; or
 - 9. Correction of Defective Work by Owner.
- D. The Contract Documents may require the Contractor to accept the assignment of a contract between the Owner and a contractor or supplier. The specific warranties, guarantees, and correction obligations contained in an assigned contract govern with respect to Contractor's performance obligations to Owner for the Work described in an assigned contract.

7.14 Correction Period

- A. Promptly correct Defective Work without cost to Owner for 1 year after the date of Substantial Completion or longer periods of time prescribed by the terms of the Contract Documents.

- B. Promptly correct damages to the Site or adjacent areas that Contractor has arranged to use through construction easements or other agreements. Promptly correct damages to Work or the work of others. Make corrections without cost to Owner.
- C. Owner may have the Defective Work and damages described in Paragraphs 7.14.A and 7.14.B corrected if Contractor does not comply with the terms of Construction Manager's instructions, or in an emergency where delay would cause serious risk of loss or damage.
- D. NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS AGREEMENT OR THE CONTRACT DOCUMENTS AND TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, THE CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE CORRECTION OF DEFECTIVE WORK.
- E. The correction period starts to run from the date when a specific item of equipment or systems are placed in continuous beneficial use by Owner before Substantial Completion of Work if so provided in the Specifications or if accepted for beneficial use by the Owner.
- F. The correction period is extended for an additional period of 1 year for Defective Work corrected after the date of Substantial Completion or after the accepted date the correction period starts to run as described in Paragraph 7.14.E. This extended correction period starts to run when Defective Work has been satisfactorily corrected under this Paragraph 7.14.
- G. Contractor's obligations under this Paragraph 7.14 are in addition to other obligations or warranties. The provisions of this Paragraph 7.14 are not a substitute for, or a waiver of, the provisions of applicable statutes of limitation or repose.

7.15 Indemnification

- A. TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, AND IN ADDITION TO ANY OTHER OBLIGATIONS OF CONTRACTOR UNDER THE CONTRACT OR OTHERWISE, CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER'S INDEMNITEES FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS ARISING OUT OF OR RELATING TO THE PERFORMANCE OF THE WORK, PROVIDED THAT ANY SUCH CLAIM, ACTION, LOSS, OR DAMAGE IS ATTRIBUTABLE TO BODILY INJURY, SICKNESS, DISEASE, OR DEATH, OR TO DAMAGE TO OR DESTRUCTION OF TANGIBLE PROPERTY (OTHER THAN THE WORK ITSELF), INCLUDING THE LOSS OF USE RESULTING THEREFROM BUT ONLY TO THE EXTENT CAUSED BY ANY NEGLIGENT ACT OR OMISSION OF CONTRACTOR'S TEAM.
- B. The indemnification obligation under Paragraph 7.15.A is not limited by the amount or type of damages, compensation, or benefits payable by or for members of the Contractor's Team or other individuals or entities under workers' compensation acts, disability benefit acts, or other employee benefit acts in claims against Owner's Indemnitees by an employee or the survivor or personal representative of employee of Contractor's Team.
- C. The indemnification obligations of Contractor under Paragraph 7.15.A do not extend to the liability of Design Professional arising out of the preparation of the Contract Documents or giving directions or instructions, or failing to give them, to the extent they are obligated to do so if that is the primary cause of the injury or damage.

7.16 Delegation of Professional Design Services

- A. Contractor is to provide professional design services required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures.
- B. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. This delegation will specify the performance and design criteria that such services must satisfy and the Submittals that Contractor must furnish to Construction Manager with respect to the Owner delegated design. Contractor is not required to provide these professional services in violation of applicable Laws and Regulations.
- C. Owner-delegated professional design services provided through the Contractor are to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and other Submittals prepared by such design professional. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Construction Manager, then such Shop Drawing or other Submittal must bear the design professional's written approval when submitted by Contractor to Construction Manager.
- D. OPT is entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by Contractor's design professionals, provided OPT has specified to Contractor the performance and design criteria that these services must satisfy.
- E. Pursuant to this Paragraph 7.16, OPT's review and approval of design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
 - 1. Checking for conformance with the requirements of this Paragraph 7.16;
 - 2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
 - 3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- F. Contractor is not responsible for the adequacy of the performance or design criteria specified by OPT. Advise OPT if the performance or design criteria are known or considered likely to be inadequate or otherwise deficient.

ARTICLE 8 – OTHER WORK AT THE SITE

8.01 Other Work

- A. Owner may arrange for other work at or adjacent to the Site which is not part of the Contractor's Work. This work may be performed by Owner's employees or through other contractors. Utility owners may perform work on their utilities and facilities at or adjacent to the Site. Include costs associated with coordinating with entities performing other work or associated with connecting to other work in the Contract Price if other work is shown in the Contract Documents.

- B. OPT is to notify Contractor of other work prior to starting the work and provide any knowledge they have regarding the start of utility work at or adjacent to the Site to Contractor.
- C. Provide other contractors:
 - 1. Proper and safe access to the Site;
 - 2. Reasonable opportunity for the introduction and storage of materials and equipment; and
 - 3. Reasonable opportunity to execute their work.
- D. Provide cutting, fitting, and patching of the Work required to properly connect or integrate with other work. Do not endanger the work of others by cutting, excavating, or otherwise altering the work of others without the consent of Construction Manager and the others whose work will be affected.
- E. Inspect the work of others and immediately notify Construction Manager if the proper execution of part of Contractor's Work depends upon work performed by others and this work has not been performed or is unsuitable for the proper execution of Contractor's Work. Contractor's failure to notify the Construction Manager constitutes an acceptance of this other work as acceptable for integration with Contractor's Work. This acceptance does not apply to latent defects or deficiencies in the work of others.
- F. Take adequate measures to prevent damages, delays, disruptions, or interference with the work of Owner, other contractors, or utility owners performing other work at or adjacent to the Site.
- G. The provisions of this Article 8 are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.03.

8.02 Coordination

- A. Owner has sole authority and responsibility for coordination of other work unless otherwise provided in the Contract Documents. The Owner is to identify the entity with authority and responsibility for coordination of the activities of the various contractors, the limitations of their authority, and the work to be coordinated prior to the start of other work at or adjacent to the Site.

8.03 Legal Relationships

- A. Contractor may be entitled to a change in Contract Price or Contract Times if, while performing other work at or adjacent to the Site for Owner, the OPT, other contractor, or utility owner:
 - 1. Damages the Work or property of Contractor's Team;
 - 2. Delays, disrupts, or interferes with the execution of the Work; or
 - 3. Increases the scope or cost of performing the Work through their actions or inaction.

- B. Notify the Construction Manager immediately of the event leading to a potential Change Proposal so corrective or mitigating action can be taken. Submit the Change Proposal within 30 days of the event if corrective action has not adequately mitigated the impact of the actions or inactions of others. Information regarding this other work in the Contract Documents is used to determine if the Contractor is entitled to a change in Contract Price or Contract Times. Changes in Contract Price require that Contractor assign rights against the other contractor or utility owner to Owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Changes in Contract Times require that the time extension is essential to Contractor's ability to complete the Work within the Contract Times.
- C. Take prompt corrective action if Contractor's Team damages, delays, disrupts, or interferes with the work of Owner's employees, other contractors, or utility owners performing other work at or adjacent to the Site or agree to compensate other contractors or utility owners for correcting the damage. Promptly attempt to settle claims with other contractors or utility owners if Contractor damages, delays, disrupts, or interferes with the work of other contractors or utility owners performing other work at or adjacent to the Site.
- D. Owner may impose a set-off against payments due to Contractor and assign the Owner's contractual rights against Contractor with respect to the breach of the obligations described in this Paragraph 8.03 to other contractors or utility owners if damages, delays, disruptions, or interference occur.
- E. NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS AGREEMENT OR THE CONTRACT DOCUMENTS AND TO THE FULLEST EXTENT PERMITTED BY LAWS AND REGULATIONS, THE CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER'S INDEMNITEES HARMLESS FROM AND AGAINST ALL CLAIMS AND INDEMNIFIED COSTS RESULTING FROM CONTRACTOR'S TEAM'S ACTION OR INACTION RELATED TO DAMAGES, DELAYS, DISRUPTIONS, OR INTERFERENCE WITH THE WORK OF OWNER'S EMPLOYEES, OTHER CONTRACTORS, OR UTILITY OWNERS PERFORMING OTHER WORK AT OR ADJACENT TO THE SITE.

ARTICLE 9 – OWNER'S AND OPT'S RESPONSIBILITIES

9.01 Communications to Contractor

- A. OPT is to issue communications to Contractor through the Construction Manager except as otherwise provided in the Contract Documents.

9.02 Replacement of OPT Members

- A. Owner may replace members of the OPT at its discretion.

9.03 Furnish Data

- A. OPT is to furnish the data required of OPT under the Contract Documents.

9.04 Pay When Due

- A. Owner is to make payments to Contractor when due as described in Paragraphs 15.01.D and 15.06.D.

9.05 Lands and Easements; Reports and Tests

- A. Owner's duties with respect to providing lands and easements are described in Paragraph 5.01. OPT will make copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site available to Contractor in accordance with Paragraph 5.03.

9.06 Insurance

- A. Owner's responsibilities with respect to purchasing and maintaining insurance are described in Section 00 73 16 "Insurance Requirements."

9.07 Modifications

- A. Owner's responsibilities with respect to Modifications are described in Article 11.

9.08 Inspections, Tests, and Approvals

- A. OPT's responsibility with respect to certain inspections, tests, and approvals are described in Paragraph 14.02.

9.09 Limitations on OPT's Responsibilities

- A. The OPT does not supervise, direct, or have control or authority over, and is not responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or related safety precautions and programs, or for failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. OPT is not responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- B. OPT is not responsible for the acts or omissions of Contractor's Team. No actions or failure to act, or decisions made in good faith to exercise or not exercise the authority or responsibility available under the Contract Documents creates a duty in contract, tort, or otherwise of the OPT to the Contractor or members of the Contractor's Team.

9.10 Undisclosed Hazardous Environmental Condition

- A. OPT's responsibility for undisclosed Hazardous Environmental Conditions is described in Paragraph 5.06.

9.11 Compliance with Safety Program

- A. Contractor is to inform the OPT of its safety programs and OPT is to comply with the specific applicable requirements of this program.

ARTICLE 10 – DESIGN PROFESSIONAL'S AND CONSTRUCTION MANAGER'S STATUS DURING CONSTRUCTION

10.01 Owner's Representative

- A. Construction Manager is the Owner's representative. The duties and responsibilities and the limitations of authority of Construction Manager as Owner's representative are described in the Contract Documents.

10.02 Visits to Site

- A. Design Professional is to make periodic visits to the Site to observe the progress and quality of the Work. Design Professional is to determine, in general, if the Work is proceeding in accordance with the Contract Documents based on observations made during these visits. Design Professional is not required to make exhaustive or continuous inspections to check the quality or quantity of the Work. Design Professional is to inform the OPT of issues or concerns and Construction Manager is to work with Contractor to address these issues or concerns. Design Professional's visits and observations are subject to the limitations on Design Professional's authority and responsibility described in Paragraph 9.09.
- B. Construction Manager is to observe the Work to check the quality and quantity of Work, implement Owner's quality assurance program and administer the Contract as Owner's representative as described in the Contract Documents. Construction Manager's visits and observations are subject to the limitations on Construction Manager's authority and responsibility described in Paragraph 9.09.

10.03 Rejecting Defective Work

- A. OPT has the authority to reject Work in accordance with Article 14. Construction Manager is to notify Contractor of Defective Work of which it is aware and document when Defective Work has been corrected or accepted in accordance with Article 14.

10.04 Decisions on Requirements of Contract Documents and Acceptability of Work

- A. Construction Manager is to render decisions regarding non-technical or contractual/administrative requirements of the Contract Documents and will coordinate the response of the OPT to Contractor.
- B. Design Professional is to render decisions regarding the conformance of the Work to the requirements of the Contract Documents. Design Professional will render a decision to either correct the Defective Work or accept the Work under the provisions of Paragraph 14.04, if Work does not conform to the Contract Documents. Construction Manager will coordinate the response of the OPT to Contractor.
- C. Construction Manager will issue a Request for a Change Proposal if a Modification is required. Construction Manager will provide documentation for changes related to the non-technical or contractual/administrative requirements of the Contract Documents. Design Professional will provide documentation if design related changes are required through the Construction Manager.
- D. Contractor may appeal OPT's decision by submitting a Change Proposal if Contractor does not agree with the OPT's decision.

ARTICLE 11 – CHANGES TO THE CONTRACT

11.01 Amending and Supplementing the Contract Documents

- A. A Contract Amendment, Change Order, Work Change Directive, or Field Order may modify the Contract Documents. Modifications that include a change in the Contract Price or Contract Times can only be made in a Contract Amendment or Change Order.

- B. Changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other design or technical matters, must be supported by Design Professional's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Design Professional.
- C. Proceed with the Changes in the Work or, in the case of a deletion in the Work, immediately cease construction activities related to the deleted Work upon receipt of the Modification.
- D. Contractor is not entitled to an increase in the Contract Price or an extension of the Contract Times with respect to Work performed that is not required by the Contract Documents, except in the case of an emergency as provided in Paragraph 7.12 or in the case of uncovering Work as provided in Paragraph 14.05. Contractor is responsible for costs and time delays associated with variations from the requirements of the Contract Documents unless the variations are specifically approved by Change Order.
- E. Acceptance of a Modification by Contractor constitutes agreement that the compensation provided by that Modification is the full, complete, and final compensation for all costs the Contractor has or may incur because of or relating to this Modification whether these costs are known, unknown, foreseen, or unforeseen at this time, including any cost for delay, extended overhead, ripple or impact cost, or any other effect on changed or unchanged Work as a result of this Modification.
- F. Acceptance of a Modification by Contractor constitutes agreement that the changes in Contract Times are the complete and final adjustments for direct impacts to the ability of the Contractor to complete the Work within the Contract Times and are the only adjustments to which the Contractor is entitled.
- G. Perform added or revised Work under the applicable provisions of the Contract Documents for the same or similar Work unless different Drawings, Specifications, or directions are provided in the Modification.
- H. Nothing in this Paragraph 11.01 obligates the Contractor to undertake Work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.02 Contract Amendments

- A. Owner and Contractor may modify the terms and conditions of the Contract Documents without the recommendation of the Design Professional using a Contract Amendment.
- B. A Contract Amendment may also be used for authorizing a new task order for task order contracts or a new phase of the Work when using phased construction or purchasing Goods and Special Services to be incorporated into the Project. The Contract Amendment may be used to establish the Contract Price, Contract Times, or terms and conditions of the Contract for the new task order or phase of Work if not already established in the Contract Documents.

11.03 Change Orders

- A. All changes to the Contract Documents that include a change in the Contract Price or the Contract Times for previously authorized Work and changes to the Work requiring Design

Professional's approval must be made by a Change Order. Change Orders prepared by the Construction Manager may cover:

1. Changes in Contract Price or Contract Times which are submitted by Contractor as a Change Proposal and agreed to by the parties;
 2. Changes in Contract Price or Contract Times to pay for undisputed Work performed in accordance with a Work Change Directive;
 3. Changes in Contract Price or Contract Times making final adjustments for Work covered under alternates and allowances;
 4. Changes in Contract Price or Contract Times making final adjustments to actual quantities for Unit Price Work;
 5. Changes in Contract Price resulting from an Owner set-off, unless the set-off has been successfully challenged by Contractor
 6. Changes in Contract Price or Contract Times resulting from resolution of Claims;
 7. Changes in Contract Price or Contract Times required because of Owner's acceptance of Defective Work under Paragraph 14.04 or Owner's correction of Defective Work under Paragraph 14.07, or
 8. Other similar provisions that will modify the Contract Price or Contract Times.
- B. A Change Order may also be used to establish modifications of the Contract Documents that do not affect the Contract Price or Contract Times.
- C. Work covered under a Change Order cannot start until the Change Order is approved.

11.04 Work Change Directives

- A. A Work Change Directive does not change the Contract Price or the Contract Times, but is evidence that the parties expect that the modifications ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations on the Contract Price and Contract Times.
- B. Contractor must submit a Change Proposal seeking an adjustment of the Contract Price or the Contract Times no later than 30 days after the completion of the Work set out in the Work Change Directive if negotiations are unsuccessful under the terms of the Contract Documents governing adjustments, expressly including Paragraphs 11.04 and 11.05.

11.05 Field Orders

- A. Design Professional may require minor changes in the Work that do not change the Contract Price or Contract Times using a Field Order issued through the Construction Manager. Construction Manager may issue a Field Order for non-technical, administrative issues. Submit a Change Proposal if Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times before proceeding with the Work described in the Field Order.

11.06 Change Proposals

- A. Submit a Change Proposal to the Construction Manager to:
 - 1. Request an adjustment in the Contract Price or Contract Times;
 - 2. Contest an initial decision by OPT concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents;
 - 3. Contest a set-off against payment due; or
 - 4. Seek other relief under the Contract Documents.
- B. Notify the Construction Manager immediately if a Change Proposal is to be submitted. Submit each Change Proposal to Construction Manager no later than 30 days after the event initiating the Change Proposal. Submit the following as part of the Change Proposal:
 - 1. Any proposed change in Contract Price, Contract Times, or other relief, accompanied by a statement that the requested Change Order is the entire adjustment to which Contractor believes it is entitled;
 - 2. The reason for the proposed change; and
 - 3. Supporting data, accompanied by a statement that the supporting data is accurate and complete.
- C. Construction Manager is to advise OPT regarding the Change Proposal. OPT is to review each Change Proposal and Contractor's supporting data, and within 30 days after receipt of the documents, direct the Construction Manager to either approve or deny the Change Proposal in whole or in part. Construction Manager is to issue a Change Order for an approved Change Proposal. Change Proposals are denied if Construction Manager does not act on the Change Proposal within 30 days. Contractor may start the time for appeal of the under Article 12 after the Change Proposal is denied.

11.07 Change of Contract Price; Contract Times

- A. Change Proposals for an adjustment in the Contract Price must comply with the provisions of this Paragraph 11.07. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12. An adjustment of the Contract Times is subject to the limitations described in Paragraph 4.03.
- B. An adjustment in the Contract Price is to be determined as follows:
 - 1. By applying unit prices to the quantities of the items involved, subject to the provisions of Paragraph 13.03, where the Work involved is covered by unit prices in the Contract Documents;
 - 2. By a mutually agreed lump sum where the Work involved is not covered by unit prices in the Contract Documents; or
 - 3. Payment based on the Cost of the Work determined as provided in Article 13 when the Work involved is not covered by unit prices in the Contract Documents or the parties do not reach a mutual agreement to a lump sum.

- C. The original Contract Price may not be increased by more than 25 percent unless further limited by Laws and Regulations. Owner may decrease the Work by up to 25 percent of the Contract Price without adjusting Contractor's fee.

11.08 Execution of Change Orders and Contract Amendments

- A. Each Change Order or Contract Amendment must be specific and final as to changes in Contract Price and Contract Times for the changes described in the Change Order or Contract Amendment. Acceptance of a Change Order or Contract Amendment by Contractor constitutes a full accord and satisfaction for all claims and costs of any kind, whether direct or indirect, including impact, delay, or acceleration damages related to the Change Order or Contract Amendment. The execution of a Change Order or Contract Amendment by Contractor constitutes conclusive evidence of Contractor's agreement to the ordered changes in the Work, with no reservations or other provisions allowing for future changes in the Contract Price or Contract Times. This Contract, as amended, forever releases any claim against Owner for additional time or compensation for matters relating to or arising out of or resulting from the Work included within or affected by the executed Change Order or Contract Amendment. This release applies to claims related to the cumulative impact of all Change Orders or Contract Amendment and to any claim related to the effect of a change on unchanged Work.
- B. A Change Order or Contract Amendment is deemed to be in full force as if executed by Contractor if the Contractor refuses to execute a Change Order or Contract Amendment that is required to be executed under the terms of this Paragraph 11.08.

11.09 Notice to Surety

- A. Notify the surety of Modifications affecting the general scope of the Work, changes in the provisions of the Contract Documents, or changes in Contract Price or Contract Times. Adjust the amount of each bond when Modifications change the Contract Price.

ARTICLE 12 – CLAIMS

12.01 Claims

- A. Follow the Claims process described in this Article for a demand or assertion by Contractor:
 - 1. Contesting an initial decision by OPT concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents;
 - 2. Contesting OPT's decision regarding a Change Proposal;
 - 3. Seeking resolution of a contractual issue that OPT has declined to address;
 - 4. Seeking other relief with respect to the terms of the Contract; or
 - 5. Any issue, request, demand, or dispute arising after Construction Manager's recommendation of Final Payment not specifically listed in the Certificate of Final Completion.
- B. Notify the Construction Manager no later than 7 days after the start of the event giving rise to the Claim or, in the case of appeals regarding Change Proposals, within 7 days of the decision under appeal. The responsibility to substantiate a Claim rests with the entity

making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Price or Contract Times, Contractor must certify that the Claim is made in good faith, that the supporting data is accurate and complete, and that to the best of Contractor's knowledge and belief, the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

- C. The entity receiving a Claim is to review the Claim and consider its merits. The Owner and Contractor are to seek to resolve the Claim through the exchange of information and direct negotiations. The Owner and Contractor may extend the time for resolving the Claim by mutual agreement. Notify Construction Manager of actions taken on a Claim.
- D. Owner and Contractor may mutually agree to mediate the underlying dispute at any time after initiation of a Claim.
 - 1. The agreement to mediate suspends the Claims process.
 - 2. Owner or Contractor may unilaterally terminate the mediation process after 60 days from the agreement to mediate and resume the Claims process as of the date of the termination. The Claim process resumes as of the date of the conclusion of the mediation, as determined by the mediator, if the mediation is unsuccessful in resolving the dispute.
 - 3. Owner and Contractor are to each pay one-half of the mediator's fees and costs.
- E. If the entity receiving a Claim approves the Claim in part or denies it in part, this action is final and binding unless the other entity invokes the procedure described in Article 17 for final resolution of disputes within 30 days of this action.
- F. Notify the Construction Manager if efforts to resolve the Claim are not successful and the Claim is denied. A denial of the Claim is final and binding unless the other entity invokes the procedure described in Article 17 for the final resolution of disputes within 30 days of the denial.
- G. The results of the agreement or action on the Claim is to be incorporated in a Change Order by the Construction Manager to the extent they affect the Contract Documents, the Contract Price, or the Contract Times if the Owner and Contractor reach an agreement regarding a Claim.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 Cost of the Work

- A. The Cost of the Work is the sum of costs described in this Paragraph 13.01, except those excluded in Paragraph 13.01.D, necessary for the proper performance of the Work. The provisions of this Paragraph 13.01 are used for two distinct purposes:
 - 1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price under cost-plus, time-and-materials, or other cost-based terms; or
 - 2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price.

- B. Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the events giving rise to the adjustment when the value of the adjustment is determined based on the Cost of the Work.
- C. Costs included in the Cost of the Work may not exceed the costs commonly incurred in the proximate area of the Site for similar work unless agreed to by the Owner. Cost of the Work includes only the following items:
 - 1. Payroll costs for Contractor's employees performing the Work, including one foreman per crew, and other required and agreed upon personnel for the time they are employed on the Work. Employees are to be paid according to wage rates for job classifications as agreed to by Owner in advance of the Work. Rates paid for this Work are to be the same as paid for Contract Work as established by certified payroll. Payroll costs may include:
 - a. Actual costs paid for salaries and wages;
 - b. Actual cost paid for fringe benefits, which consists of:
 - 1) Social security contributions,
 - 2) Unemployment,
 - 3) Excise and payroll taxes,
 - 4) Workers' compensation,
 - 5) Health and retirement benefits, and
 - 6) Paid time off for sick leave, vacations, and holidays; and
 - c. Actual cost of additional compensation paid for performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, to the extent authorized by Owner.
 - 2. Cost of materials and equipment furnished and incorporated in the Work, including transportation and storage costs, and required Suppliers' field services. Contractor may retain cash discounts unless Owner provided funds to the Contractor for early payment of these materials and equipment. Cash discounts are to be credited to Owner if the Owner provides funds for early payment. Make provisions for trade discounts, rebates, refunds, and returns from sale of surplus materials and equipment and reduce the Cost of the Work by these amounts.
 - 3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. Obtain competitive bids from Subcontractors acceptable to Owner if required by the OPT. Bids are to be opened in the presence of the Construction Manager and other designated members for the OPT. Provide copies of bids to the Construction Manager to use in determining, with the OPT, which bids are acceptable. The Subcontractor's Cost of the Work and fee are determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01 if the subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee.

4. Supplemental costs consisting of the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work;
 - b. Costs of materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site including transportation and maintenance costs related specifically to the Work;
 - c. Costs of engineers, architects, testing laboratories, surveyors, employed or retained for services specifically related to the Work.
 - d. Actual cost for construction equipment, including the costs of transporting, loading, unloading, assembling, dismantling, and removing construction equipment, whether owned by Contractor or rented from others.
 - 1) Cost for construction equipment must not exceed the cost shown in the most current edition of the EquipmentWatch Cost Recovery Rental Rate Blue Book. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
 - 2) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.
 - e. Applicable sales, consumer, use, and other similar taxes related to the Work for which the Owner is not exempt, and which Contractor pays consistent with Laws and Regulations;
 - f. Deposits lost for causes other than negligence of Contractor's Team;
 - g. Royalty payments and fees for permits and licenses;
 - h. Cost of additional utilities, fuel, and sanitary facilities at the Site;
 - i. Minor expense items directly required by the Work; and
 - j. Premiums for bonds and insurance required by the Contract Documents.
- D. The Cost of the Work does not include the following administrative costs which are to be covered by the Contractor's fee:
 1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, safety managers, superintendents, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office, for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.C..1.

2. The cost of purchasing, renting, or furnishing any tool or equipment whose current price would be less than \$500 if purchased new at retail.
 3. Office expenses other than Contractor's office at the Site.
 4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
 5. Costs due to the actions of Contractor's Team for the correction of Defective Work, disposal of materials or equipment that do not comply with Specifications, and correcting damage to property.
 6. Losses, damages, and related expenses caused by damage to the Work or sustained by Contractor in connection with the performance of the Work. Contractor is entitled to recover costs if covered by Owner's insurance, if applicable. Such losses may include settlements made with the approval of Owner. Do not include these losses, damages, and expenses in the Cost of the Work when determining Contractor's fee.
 7. Expenses incurred in preparing and advancing Claims.
 8. Any Indemnified Costs paid regarding Contractor's indemnification of Owner's Indemnitees.
 9. Other overhead or general expense costs and the costs of items not described in Paragraph 13.01.C.
 10. The Contractor's fee is determined in accordance with the Agreement when the Work is performed on a cost-plus basis.
- E. The Contractors Fee is determined as follows for Work included in a Change Proposal.
1. The Contractor's fee is 15 percent of the costs included in the Cost of the Work per Paragraph 13.01.C..1 for payroll costs and per Paragraph 13.01.C..2 for cost of materials and equipment furnished and incorporated in the Work.
 2. The Contractor's fee is 5 percent of costs included in the Cost of the Work paid by Contractor for Work performed by Subcontractors per Paragraph 13.01.C..3.
 3. No fee will be payable for costs included in the Cost of the Work for supplemental costs per Paragraph 13.01.C..4.
 4. Fees are to be determined as follows where one or more tiers of Subcontracts are used:
 - a. The Subcontractor's fee is 15 percent for costs incurred under Paragraphs 13.01.C (excluding Paragraph 13.01.C..3) for the Subcontractor that performs the Work;
 - b. The Contractor and Subcontractors of a tier higher than that of the Subcontractor that performs the Work are allowed a fee of 5 percent of the total costs incurred by the next lower tier Subcontractor; and
 - c. Regardless of the number of subcontractor tiers involved, the maximum total fee to be paid by the Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that performs the Work.
- F. When a Change Proposal includes additions and credits, the Contractor's fee will be calculated on the sum of costs for each cost category in Paragraph 13.01.C. and applying

the appropriate fee from Paragraph 13.01.E. The amount to be credited by Contractor to Owner for any Change Proposal which results in a net decrease in the Cost of Work will be the amount of the actual net decrease in the Cost of Work plus an additional amount equal to 5 percent of the actual net decrease in the Cost of Work.

- G. Establish and maintain records in accordance with generally accepted accounting practices and submit these records, including an itemized cost breakdown together with supporting data, in a form and at intervals acceptable to Construction Manager whenever the Cost of the Work is to be determined pursuant to this Paragraph 13.01.

13.02 Allowances

- A. Include allowances specified in the Contract Documents in the Contract Price and provide Work covered by the allowance as authorized by the Owner through the Construction Manager.
- B. Contractor agrees that:
 - 1. The cash allowance is used to compensate the Contractor for the cost of furnishing materials and equipment for the Work covered by the allowance item in the Contract Documents. Cost may include applicable taxes. Make provisions for trade discounts, rebates, and refunds and reduce the allowance costs by these amounts.
 - 2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances; and
 - 3. Costs for cash allowances and installation costs as described in Paragraphs 13.02.B..1 and 13.02.B..2 above are included in the Contract Price.
- C. Construction Manager will issue a Change Order to adjust the Contract Price by the difference between the allowance amount and the actual amount paid by Contractor for Work covered by the allowance. The Change Order will be issued at the time costs are incurred by Contractor for Work covered by the allowance and this Work is included on the Application for Payment.

13.03 Unit Price Work

- A. The initial Contract Price for Unit Price Work is equal to the sum of the unit price line items in the Agreement. Each unit price line item amount is equal to the product of the unit price for each line item times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparing offers and determining an initial Contract Price. Payments to Contractor for Unit Price Work are to be based on actual quantities measured for Work in place.
- C. Each unit price is deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Construction Manager is to determine the actual quantities and classifications of Unit Price Work performed by Contractor to be incorporated into each Application for Payment. Construction Manager's decision on actual quantities is final and binding, subject to the provisions of Paragraph 13.03.E.

- E. Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price within 30 days of Construction Manager's decision under Paragraph 13.03.D, if:
 - 1. The total cost of a particular item of Unit Price Work amounts to 25 percent or more of the total Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by the Contractor differs by more than 25 percent from the estimated quantity of an item indicated in the Agreement;
 - 2. There is no corresponding adjustment with respect to other items of Work; and
 - 3. Contractor believes it has incurred additional expense as a result of this condition or if Owner believes that the quantity variation entitles Owner to an adjustment in the Contract Price.
- F. Construction Manager will issue a Change Order adjusting estimated quantities to actual quantities to determine the final Contract Price.

13.04 Contingencies

- A. Contingency funds may be included in the Contract Price to pay for Work not defined specifically by the Contract Documents that is essential to the completion of the Project. Contingency funds will be as described in the Agreement.
- B. The contingency funds may be used for costs incurred by the Contractor provided these costs are approved by the Owner. Costs are to be determined and documented in accordance with Paragraph 13.01. The contingency funds are not to be used for the following items:
 - 1. Cost overruns due to changes in material costs after the Contract Price is established, unless specific price escalation provisions are made in the Agreement.
 - 2. Rework required to correct Defective Work.
 - 3. Inefficiencies in completing the Work due to the Contractor's selected means, methods, sequences, or procedures of construction.
 - 4. Work Contractor failed to include in the Contract Price.
 - 5. Changes required by changes in Laws and Regulations enacted after the Contract Price is established.
 - 6. Any Work that does not constitute a change in Scope in the Work included in the Contract Price.
- C. Construction Manager is to issue a Change Order for approved expenditures from contingency funds. When the Change Order is issued, the costs are to be added to the Application for Payment. Contractor is to maintain a tabulation showing the contingency amount, adjustments to the contingency amount, and amounts remaining as the Project progresses.
- D. Any contingency amounts that are not included in a Change Order are retained by the Owner. A Change Order will be issued to deduct unused contingency amounts from the Contract Price prior to Final Payment.

ARTICLE 14 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 Access to Work

- A. Provide safe access to the Site and the Work for the observation, inspection, and testing of the Work in progress. Contractor can require compliance with Contractor's safety procedures and programs as part of providing safe access.

14.02 Tests, Inspections, and Approvals

- A. OPT may retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform inspections. Cooperate with inspection and testing personnel and assist with providing access for required inspections, tests, and handling test specimens or Samples.
- B. Arrange for and facilitate inspections, tests, and approvals required by Laws or Regulations of governmental entities having jurisdiction that require Work to be inspected, tested, or approved by an employee or other representative of that entity. Pay associated costs and furnish Construction Manager with the required certificates of inspection or approval.
- C. Arrange, obtain, and pay for inspections and tests required:
 - 1. By the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to OPT;
 - 2. To attain OPT's acceptance of materials or equipment to be incorporated in the Work;
 - 3. By manufacturers of equipment furnished under the Contract Documents;
 - 4. For testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work;
 - 5. For acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work;
 - 6. For re-inspecting or retesting Defective Work, including any associated costs incurred by the testing laboratory for cancelled tests or standby time; and
 - 7. For retesting due to failed tests.
- D. Provide independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to OPT to provide these inspections and tests.

14.03 Defective Work

- A. It is Contractor's obligation to ensure that the Work is not Defective.
- B. OPT has the authority to determine whether Work is Defective and to reject Defective Work.
- C. Construction Manager is to notify Contractor of Defective Work of which OPT has actual knowledge.
- D. Promptly correct Defective Work.

- E. Take no action that would void or otherwise impair Owner's special warranties or guarantees when correcting Defective Work.
- F. Pay claims, costs, losses, and damages arising out of or relating to Defective Work, including:
 - 1. Costs for correction, removal, and replacement of Defective Work;
 - 2. Cost of the inspection and testing related to correction of Defective Work;
 - 3. Costs for Design Professional's fees associated with review and approval of design modifications for correction, removal, and replacement of Defective Work.
 - 4. Fines levied against Owner by governmental authorities because of Defective Work; and
 - 5. Costs of repair or replacement of work of others resulting from Defective Work.

14.04 Acceptance of Defective Work

- A. Owner may elect to accept Defective Work instead of requiring correction or removal and replacement of Defective Work provided:
 - 1. This acceptance occurs prior to final payment;
 - 2. Design Professional confirms that the Defective Work is in general accordance with the design intent and applicable design principles; and
 - 3. Design Professional confirms that acceptance of the Defective Work does not endanger public health or safety.
- B. Owner may impose a reasonable set-off against payments due under Article 15 for costs associated with OPT's evaluation of Defective Work to determine if it can be accepted and to determine the diminished value of the Work. Owner may impose a reasonable set-off against payments due under Article 15 if the parties are unable to agree as to the decrease in the Contract Price to compensate Owner for the diminished value of Defective Work accepted. Construction Manager is to issue a Change Order for acceptance of the Defective Work prior to final payment. Pay an appropriate amount to Owner if the acceptance of Defective Work occurs after final payment.

14.05 Uncovering Work

- A. OPT has the authority to require inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
- B. Work that is covered prior to approval of the Construction Manager must be uncovered for OPT's observation if requested by Construction Manager. Pay for uncovering Work and its subsequent restoration unless Contractor has given Construction Manager timely notice of Contractor's intention to cover the Work and Construction Manager fails to act with reasonable promptness in response to this notice.
- C. Provide necessary labor, material, and equipment and uncover, expose, or otherwise make available the portion of the Work suspected of being Defective for observation, inspection, or testing if OPT considers it necessary or advisable that covered Work be observed by

Design Professional or inspected or tested by others as directed by the Construction Manager.

1. Pay for claims, costs, losses, and damages associated with uncovering, exposing, observing, inspecting, and testing if it is found that the uncovered Work is Defective. Pay costs for correction of Defective Work. Pay for reconstruction, repair, or replacement of work of others if it is found that the uncovered Work is Defective.
2. Submit a Change Proposal for an increase in the Contract Price or an extension of the Contract Times directly attributable to this uncovering, exposure, observation, inspection, testing, and reconstruction if the uncovered Work is found to not be Defective.

14.06 Owner May Stop the Work

- A. Owner may order Contractor to stop the Work if:
 1. The Work is Defective;
 2. Contractor fails to supply adequate skilled workers or suitable materials or equipment; or
 3. Contractor performs Work that may fail to conform to the Contract Documents when completed.
- B. This stop work order is to remain in effect until the reason for the stop work order has been eliminated. Owner's right to stop the Work does not create a duty to exercise this right for the benefit of Contractor's Team or surety.

14.07 Owner May Correct Defective Work

- A. Owner may remedy Defective Work after 7 days' notice to Contractor if Contractor fails to correct Defective Work, or to remove and replace Defective Work as required by OPT;
- B. Owner may:
 1. Exclude Contractor from the Site;
 2. Take possession of the Work and suspend Contractor's services related to the Work; and
 3. Incorporate stored materials and equipment in the Work.
- C. Allow OPT access to the Site and off-site storage areas to enable Owner to exercise the rights and remedies under this Paragraph 14.07.
- D. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 are to be charged against Contractor as a set-off against payments due under Article 15. These claims, costs, losses, and damages include costs of repair and the cost of replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's Defective Work.
- E. Contractor is not allowed an extension of the Contract Times because of delays in the performance of the Work attributable to the exercise of the Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; FINAL COMPLETION

15.01 Progress Payments

- A. Progress payments are to be submitted to the Construction Manager on the Application for Payment form provided by the Construction Manager following procedures in the Contract Documents.
 - 1. Progress payments for lump sum Work are to be paid based on the earned value to date at the amounts shown in the Schedule of Values submitted as required by Paragraph 2.03. Final payment will be for the total lump sum amount.
 - 2. Progress payments for Unit Price Work are based on the number of units completed as determined under the provisions of Paragraph 13.03.
 - 3. Progress payments for Work to be paid based on the Cost of the Work per Paragraphs 13.01, 13.02, and 13.04 are to be paid for Work completed by Contractor during the pay period.
- B. Reduction in Payment by Owner:
 - 1. Owner is entitled to impose a set-off against payment based on the following:
 - a. Claims made against Owner or costs, losses, or damages incurred by Owner related to:
 - 1) Contractor's conduct in the performance of the Work, including workplace injuries, non-compliance with Laws and Regulations, or patent infringement; or
 - 2) Contractor's failure to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site, including workplace injuries, property damage, and non-compliance with Laws and Regulations.
 - b. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
 - c. Work is Defective, or completed Work has been damaged by Contractor's Team, requiring correction or replacement;
 - d. Owner has been required to correct Defective Work or complete Work in accordance with Paragraph 14.07;
 - e. The Contract Price has been reduced by Change Orders;
 - f. Events have occurred that would constitute a default by Contractor justifying a termination for cause;
 - g. Liquidated or other damages have accrued because of Contractor's failure to achieve Milestones, Substantial Completion, or completion of the Work;
 - h. Liens have been filed regarding the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of these Liens;

- i. Owner has been notified of failure to make payments to Subcontractors, Suppliers, or Employees;
 - j. Failure to submit up-to-date record documents as required by the Contract Documents;
 - k. Failure to submit monthly Progress Schedule updates or revised schedules as requested by the Construction Manager;
 - l. Failure to provide Project photographs or video required by the Contract Documents;
 - m. Failure to provide Certified Payroll required by the Contract Documents;
 - n. Compensation for OPT for overtime charges of Construction Manager, third review of Shop Drawings, review of substitutions, re-inspection fees, inspections or designs related to correction of Defective Work, or other services identified as requiring payment by the Contractor;
 - o. Costs for tests performed by the Owner to verify that Work previously tested and found to be Defective has been corrected;
 - p. OPT has actual knowledge of the occurrence of events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents with associated cost impacts;
 - q. Payment would result in an over-payment of the Contract Price; or
 - r. Other items entitling Owner to a set-off against the amount recommended.
- 2. Compensation for services of OPT staff is to be at the rates established in the Supplementary Conditions.
 - 3. Construction Manager is to notify Contractor stating the amount and the reasons for an imposed set-off. The Owner is to pay the Contractor amounts remaining after deduction of the set-off. Owner is to pay the set-off amount agreed to by Owner and Contractor if Contractor remedies the reasons for the set-off. Contractor may submit a Change Proposal contesting the set-off.
- C. No payment will be made for Work authorized by a Work Change Directive until the Work Change Directive is incorporated into a Change Order, unless arrangements or interim payments have been included in the Work Change Directive. Payment can be included in an Application for Payment when the Change Order is approved.
 - D. The Owner is to pay the amount of payment recommended by the Construction Manager within 30 days after receipt of the Application for Payment and accompanying documentation from the Construction Manager.
 - E. Contractor certifies that all Work, including materials, covered by each Application for Payment have been completed or delivered and stored in accordance with the Contract Documents, that all amounts have been paid for Work, materials, and equipment for which previous payment has been made by the Owner, and that the current payment amount shown in this Application for Payment is due.

15.02 Contractor's Warranty of Title

- A. Contractor warrants and guarantees that title to the Work, materials, and equipment furnished under the Contract is to pass to Owner free and clear of Liens, title defects, and patent, licensing, copyright, or royalty obligations no later than 7 days after the time of payment by Owner of the Application for Payment which includes these items.

15.03 Substantial Completion

- A. Notify Construction Manager when the Work or portion of the Work to be accepted under Paragraph 15.04 is substantially complete and request a Certificate of Substantial Completion.
- B. OPT is to inspect the Work after Contractor's notification to determine if the Work is substantially complete. Construction Manager is to either issue the Certificate of Substantial Completion which sets the date of Substantial Completion or notify Contractor of the reasons the Project is not considered to be substantially complete.
- C. The OPT and Contractor are to meet to discuss Owner's use or occupancy of the Work following Substantial Completion. Items to be discussed at this meeting include:
 - 1. Review of insurance policies with respect to the end of the Contractor's coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner;
 - 2. Owner's assumption of responsibility for security, operation, protection of the Work, maintenance, and utilities upon Owner's use or occupancy of the Work;
 - 3. Contractor's obligations for operations and maintenance during performance and acceptance testing;
 - 4. Contractor's access to the Site to complete punch list items; and
 - 5. Procedures for correction of Defective Work during the one-year correction period.

15.04 Partial Utilization

- A. Owner may use or occupy substantially completed parts of the Work which are specifically identified in the Contract Documents, or which OPT and Contractor agree constitutes a separately functioning and usable part of the Work prior to Substantial Completion of the Work. Owner must be able to use that part of the Work for its intended purpose without significant interference with Contractor's performance of the remainder of the Work. Contractor and OPT are to follow the procedures of Paragraph 15.03 for this part of the Work.
- B. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Article 6.

15.05 Final Inspection

- A. OPT is to make a final inspection upon notice from Contractor that the entire Work or portion to be accepted under Paragraph 15.04 is complete. Construction Manager is to notify Contractor of Work determined to be incomplete or Defective. Immediately take corrective measures to complete the Work and correct Defective Work.

- B. Notify Construction Manager when the entire Project is ready for Final Payment under Paragraph 15.06 and request a Certificate of Final Completion.
- C. OPT is to inspect the Work after Contractor's notification to determine if the Project is complete. Construction Manager is to either issue the Certificate of Final Completion which sets the date of Final Completion or notify Contractor of the reasons the Project is not considered to be complete.

15.06 Final Payment

- A. Make application for final payment after completing required corrections identified during the final inspection and delivering items and documents required by the Contract Documents. Provide the following with the final Application for Payment:
 - 1. Consent of Surety to Final Payment acknowledging unsettled disputes; or
 - 2. Affidavit of Payment of Debts and Claims or Affidavit of Release of Liens or furnish receipts or releases from Subcontractors and Suppliers when a payment bond is not required.
- B. Construction Manager is to either recommend payment of the final Application for Payment to Owner if OPT is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled or notify the Contractor of the OPT's reasons for not recommending final payment.
- C. The Work is complete, subject to surviving obligations, when it is ready for final payment as established by the Construction Manager's recommendation of payment of the final Application for Payment to Owner and the issuance of a Certificate of Final Completion.
- D. The Owner is to pay the amount of final payment recommended by the Construction Manager within 30 days after receipt of the final Application for Payment and accompanying documentation from the Construction Manager; unless additional time is required for approval of a governing board or entity. Payment will be within 30 days of approval by the governing board or entity.

15.07 Waiver of Claims

- A. The making of final payment does not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from:
 - 1. Unsettled Liens or claims for non-payment;
 - 2. Defective Work appearing after final inspection pursuant to Paragraph 15.05;
 - 3. Contractor's failure to comply with the terms of special guarantees specified in the Contract Documents;
 - 4. Outstanding Claims or express reservation of rights by Owner; or
 - 5. Contractor's continuing obligations under the Contract Documents.
- B. Contractor waives claims and rights against Owner by accepting final payment except for those Claims made in accordance with the provisions of Article 17 and specifically noted in the Certificate of Final Completion.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 Owner May Suspend Work

- A. Owner may suspend the Work or a portion of the Work for a period of not more than 90 consecutive days, at any time and without cause, by notice to Contractor. This notice fixes the date on which Contractor is to resume Work. Contractor is entitled to adjustments in the Contract Price and Contract Times directly attributable to this suspension. Submit a Change Proposal seeking an adjustment no later than 30 days after the date fixed for resumption of Work.

16.02 Owner May Terminate for Cause

- A. The occurrence of one or more of the following events constitutes a default by Contractor and justifies termination for cause:
 - 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents, including failure to supply adequate skilled workers or suitable materials or equipment;
 - 2. Failure to adhere to the Progress Schedule;
 - 3. Failure of the Contractor to provide a satisfactory replacement bond or insurance in the event either is lost or canceled;
 - 4. Failure of Contractor to maintain financial solvency to adequately complete the Project as indicated by one or more of the following:
 - a. A petition of bankruptcy is filed by or against Contractor,
 - b. Contractor is adjudged as bankrupt or insolvent,
 - c. Contractor or surety makes a general assignment for the benefit of creditors,
 - d. A receiver is appointed for the benefit of Contractor's creditors, or
 - e. A receiver is appointed because Contractor's insolvency;
 - 5. Contractor's disregard of Laws or Regulations of public bodies having jurisdiction; or
 - 6. Contractor's repeated disregard of the authority of OPT.
- B. Contractor and surety must provide adequate assurance of future performance in accordance with the Contract Documents that is satisfactory to Owner if Contractor is believed to be in financial distress due to the existence of one or more of the indicators listed in Paragraph 16.02.A.4. Owner may terminate this Contract if Contractor and surety fail to provide adequate documentation satisfactory to Owner within 10 days of Construction Manager's request for this information.
- C. Owner may declare Contractor to be in default, give notice to Contractor and surety that the Contract is terminated, and enforce the rights available to Owner under the performance bond after giving Contractor and surety 10 days' notice that one or more of the events identified in Paragraph 16.02.A has occurred.

- D. Owner may exclude Contractor from the Site, take possession of the Work, incorporate the materials and equipment stored and complete the Work as Owner may deem expedient if Owner has terminated the Contract for cause.
- E. Owner may elect not to proceed with termination of the Contract under this Paragraph 16.02 if Contractor begins to cure the cause for termination within 7 days of receipt of notice of intent to terminate.
- F. Contractor is not entitled to receive further payments until the Work is completed if Owner proceeds as provided in this Paragraph 16.02. The amount of the Contract Price remaining is to be paid to the Contractor if the unpaid balance exceeds the cost to complete the Work. This cost to complete the Work may include related claims, costs, losses, damages, and the fees and charges of engineers, architects, attorneys, and other professionals retained by Owner. Pay the difference to Owner if the cost to complete the Work including related claims, costs, losses, and damages exceeds the unpaid balance of the Contract Price. Claims, costs, losses, and damages incurred by Owner are to be reviewed as to their reasonableness and incorporated in a Change Order by Construction Manager. Owner is not required to obtain the lowest price for the Work performed when exercising its rights or remedies under this Paragraph 16.02.
- G. Termination does not affect the rights or remedies of Owner against Contractor or against surety under the payment bond or performance bond. Owner does not release Contractor from liability by paying or retaining money due Contractor.

16.03 Owner May Terminate for Convenience

- A. Owner may terminate the Contract without cause after giving 7 days' notice to Contractor of the effective date of termination. Contractor is to be paid for the following if Owner terminates for convenience:
 - 1. Work completed in accordance with the Contract Documents prior to the effective date of termination;
 - 2. Actual costs sustained prior to the effective date of termination for Work in progress, plus a fair and reasonable amount for overhead and profit; fee calculated in accordance with Paragraph 13.01; and
 - 3. Reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor will not be paid for loss of anticipated profits or revenue, post termination overhead costs, or other economic loss arising out of or resulting from this termination.

16.04 Contractor May Stop Work or Terminate

- A. Contractor may terminate the Contract and issue a Change Proposal requesting payment from Owner on the same terms as provided in Paragraph 16.03 after 10 days' notice to Construction Manager provided that, through no act or fault of Contractor:
 - 1. The Work is suspended for more than 90 consecutive days by Owner;
 - 2. Construction Manager fails to act on an Application for Payment within 30 days after it is submitted; or

3. Owner fails to pay Contractor sums determined to be due, other than the final payment, within 30 days after payment is recommended by Construction Manager; and
 4. OPT does not remedy this suspension or failure within 10 days after receipt of the notice.
- B. Contractor may stop Work, without prejudice to other rights or remedies in lieu of terminating the Contract if Construction Manager has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed to pay Contractor within 30 days after payment is recommended by Construction Manager. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times for damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 Methods and Procedures

- A. The Owner or Contractor may appeal a Claim, approved or denied in part or in full, by:
1. Electing to invoke the dispute resolution process if one is provided for in the Supplementary Conditions;
 2. Agreeing with the other party to submit the dispute to a dispute resolution process; or
 3. Notifying the other party of the intent to submit the dispute to a court of competent jurisdiction if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to.

ARTICLE 18 – MISCELLANEOUS

18.01 Computation of Times

- A. Exclude the first day and include the last day when determining dates for a period referred to in the Contract Documents by days. The last day of this period is to be omitted from the determination if it falls on a Saturday, Sunday, or a legal holiday.
- B. A fixed date contract is one in which the calendar dates for reaching Substantial Completion and/or Final Completion are specified in lieu of identifying the number of days involved.

18.02 Independent Contractor

- A. Contractor is to perform its duties under this Contract as an independent contractor. The Contractor's Team and their personnel are not considered to be employees or agents of the Owner. Nothing in this Agreement is to be interpreted as granting Contractor's Team the right or authority to make commitments for the Owner. This Agreement does not constitute or create a joint venture, partnership, or formal business organization of any kind.

18.03 Cumulative Remedies

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available to the Owner or Contractor by these General Conditions are in addition to, and are not a limitation of, the rights and remedies which are otherwise imposed or available by:
 - 1. Laws or Regulations;
 - 2. Special warranties or guarantees; or
 - 3. Other provisions of the Contract Documents.
- B. The provisions of this Paragraph 18.03 are as effective as if repeated specifically in the Contract Documents regarding each duty, obligation, right, and remedy to which they apply.

18.04 Limitation of Damages

- A. Owner's Indemnitees are not liable to Contractor for claims, costs, losses, or damages sustained by Contractor's Team associated with other projects or anticipated projects.

18.05 No Waiver

- A. The failure of Owner or Contractor to enforce any provision of this Contract does not constitute a waiver of that provision, affect the enforceability of that provision, or the enforceability of the remainder of this Contract.

18.06 Severability

- A. If a court of competent jurisdiction renders a part of this Contract invalid or unenforceable, that part is to be severed and the remainder of this Contract continues in full force.

18.07 Survival of Obligations

- A. Representations, indemnifications, warranties, guarantees, and continuing obligations required by the Contract Documents survive completion and acceptance of the Work or termination of the Contract.

18.08 No Third-Party Beneficiaries

- A. Nothing in this Contract can be construed to create rights in any entity other than the Owner and Contractor. Neither the Owner nor Contractor intends to create third-party beneficiaries by entering into this Contract.

18.09 Successors and Assigns

- A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents

18.10 Assignment of Contract

- A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights or interests in the Contract will be binding on the other party without the written consent of the other party. Money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.11 No Waiver of Sovereign Immunity

- A. The Owner has not waived its sovereign immunity by entering into and performing its obligations under this Contract.

18.12 Controlling Law

- A. This Contract is to be governed by the law of the state in which the Project is located.
- B. Venue for legal proceedings lies exclusively in Tarrant County.

END OF SECTION

00 73 00 SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement Section 00 72 00 "General Conditions." The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below.

The paragraph numbers used in the Supplementary Conditions correspond to the General Condition paragraphs they modify with the prefix "SC" added—for example, "Paragraph SC-4.05." modifies General Conditions Paragraph 4.05.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

SC-1.01 *Defined Terms*

- A. The Owner's Project Team as defined in the Paragraph 1.01.A.43 of the General Conditions consists of the following organizations:
 - 1. City of Arlington, Texas
Department of Water Utilities
P.O. Box 90231
Arlington, Texas 76004-3231
 - 2. Jacobs
1999 Bryan Street, Suite 1200
Dallas, Texas 75201
 - 3. Arcadis USA Inc.
12400 Coit Road, Suite 1200
Dallas, Texas 75251
 - 4. Freese and Nichols Inc.
801 Cherry Street, Suite 2800
Fort Worth Texas, 76102

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.02 *Copies of Documents*

- A. Delete Paragraph 2.02.A in its entirety and insert the following in its place:
 - "A. Owner will furnish 3 printed copies of the Contract Documents (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction."
- B. Supplement Paragraph 2.04 of the General Conditions by adding the following paragraph:
 - "G. Requests by Contractor for Electronic Documents in Other Formats:
 - 1. Release of any Electronic Document versions of the Project documents in formats other than those identified in Paragraph 2.04.F will be at the discretion of the OPT.

2. To the extent determined by OPT, release of Electronic Documents versions of Project documents and other Project information requested by Contractor ("Request") in formats other than those identified in Paragraph 2.04.F will be subject to the provisions of the Owner's response to the Request, and to the following conditions:
 - a. The content included in the Electronic Documents covered by the Request was prepared by Design Professional as an internal working document solely for Design Professional's purposes, and is being provided to Contractor on an "AS IS" basis without any warranties of any kind, including, any implied warranties of fitness for any purpose. As such, Contractor is advised and acknowledges that the content may not be suitable for Contractor's application or may require substantial modification and independent verification by Contractor. The content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other devices that may affect subsequent reuse.
 - b. Electronic Documents containing text, graphics, metadata, or other types of data that are provided by Design Professional to Contractor under the Request are only for convenience of Contractor. Any conclusion or information obtained or derived from such data will be at the Contractor's sole risk and the Contractor waives any claims against Design Professional or Owner arising from use of data in Electronic Documents covered by the Request.
 - c. CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS OWNER AND DESIGN PROFESSIONAL AND THEIR SUBCONSULTANTS FROM ALL CLAIMS, DAMAGES, LOSSES, AND EXPENSES, INCLUDING ATTORNEYS' FEES AND DEFENSE COSTS ARISING OUT OF OR RESULTING FROM CONTRACTOR'S USE, ADAPTATION, OR DISTRIBUTION OF ANY ELECTRONIC DOCUMENTS PROVIDED UNDER THE REQUEST.
 - d. Contractor agrees not to sell, copy, transfer, forward, give away or otherwise distribute this information (in source or modified file format) to any third party without the direct written authorization of Design Professional, unless such distribution is specifically identified in the Request and is limited to Contractor's subcontractors. Contractor warrants that subsequent use by Contractor's subcontractors complies with all terms of the Contract Documents and Owner's response to Request.
3. If the Owner elects to provide or directs the Design Professional to provide to Contractor any Contractor-requested Electronic Document versions of Project information that is not explicitly identified in the Contract Documents as being available to Contractor, the Owner shall be reimbursed by Contractor on an hourly basis for any costs necessary to create or otherwise prepare the data in a manner deemed appropriate by Design Professional at the rates set for in Article 15."

ARTICLE 5 – SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.03 *Subsurface and Physical Conditions*

- A. This Supplementary Condition identifies the reports and drawings referenced in Paragraph 5.03 of the General Conditions related to subsurface and physical conditions.

1. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Report Date	Technical Data
Geotechnical Investigation John Kubala Water Treatment Plant	October, 2019	Geotechnical information

2. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawing Title	Drawing Date	Technical Data
Arlington, TX Southwest Water Treatment Plant	1986	Record Drawings
Southwest WTP Modifications Project	1997	Record Drawings
John F. Kubala WTP Expansion Project	2000	Record Drawings
John F. Kubala Expansion II Project	2008	Record Drawings
Electrical Power Distribution Improvements and Back-up Power Modifications – John F. Kubala WTP	2018	Record Drawings

3. Copies of reports and drawings may be downloaded from the project procurement website.

SC-5.06 *Hazardous Environmental Conditions at Site*

- A. This Supplementary Condition identifies the reports and drawings referenced in Paragraph 5.06 of the General Conditions related to Hazardous Environmental Conditions at the Site.

1. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Report Date	Technical Data
No Reports		

2. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawing Title	Drawing Date	Technical Data
No Drawings		

3. Copies of reports and drawings may be downloaded from the project procurement website.

ARTICLE 6 – BONDS AND INSURANCE

SC-6.01 Performance, Payment, and Other Bonds

- A. Contractor is to notify Subcontractors and Suppliers that any request related to payment bond and payment information per Paragraph 6.01.B.3 of the General Conditions are to be sent to the Owner to the attention of:

Ashley Brown
 Attention Second Floor Water Utilities
 101 West Abram Street
 Arlington, Texas 76010

- B. Supplement Paragraph 6.01.D of the General Conditions by adding the following subparagraph(s):
- “1. Contractor must provide a maintenance bond in accordance with the maintenance bond form provided in the Contract Documents. Surety company providing the maintenance bond must be the same surety company that provides the performance bond for the Project. The term and amount of the bond will be as specified in the bond form.”

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; FINAL COMPLETION

SC-15.01 Progress Payments

- A. Compensation for services of OPT staff as specified in Paragraph 15.01 will be at the following rates:

Position	Hourly Rate
Principal in Charge	\$260
Project Manager	\$260
Project Engineer	\$178
Technician	\$153
Junior Discipline Engineer	\$122
Process Specialist	\$226
Junior Engineer	\$121
Professional Engineer I	\$139
Professional Engineer II	\$163
Professional Engineer III	\$201

Position	Hourly Rate
Senior Engineer	\$282
Construction Manager	\$215
Resident Engineer	\$215
Project Construction Manager	\$215
Clerk	\$112

- B. Expenses will be billed at the actual cost multiplied by 1.05.

SC-15.03 Substantial Completion

- A. Laboratory processes must be operational with all appurtenances, power, automation, labeling, etc. as specified.

END OF SECTION

00 73 16 INSURANCE REQUIREMENTS

ARTICLE 1 – GENERAL PROVISIONS

1.01 CONTRACTOR'S INSURANCE

- A. Obtain and maintain insurance that complies with this Section with coverage amounts equal to or greater than the amounts specified in Article 2 or greater where required by Laws and Regulations.
- B. Coverage is to remain in effect at least until the Work is complete and longer if expressly required elsewhere in this Contract, and when Contractor may be correcting, removing, or replacing Defective Work as a warranty or correction obligation, or returning to the Site to conduct other tasks arising from the Contract.
- C. Coverage is to apply with respect to the performance of the Work, whether performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.
- D. Obtain insurance from companies that are duly licensed or authorized in the state in which the Project is constructed to issue insurance policies for the required limits and coverages and that have an A.M. Best rating of A-VII or better.
- E. Alternative forms of insurance coverage, including self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not acceptable to meet the insurance requirements of this Contract.
- F. Owner will not purchase or maintain insurance to protect the interest of the Contractor, Subcontractors, or others in the Work. Owner does not represent that the insurance coverage and limits established in this Contract are adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary and including the cost of this insurance in the offered Contract Price.
- G. Contractor is fully responsible for all losses arising out of, resulting from or connected with operations under this Contract whether or not these losses are covered by insurance. The acceptance of evidence of insurance by the OPT, or others listed as an additional insured, that does not comply with the Contract requirements does not release the Contractor from the requirement to comply with Contract requirements.
- H. The required insurance and insurance limits do not limit the Contractor's liability under the indemnities granted to Owner's Indemnitees in the Contract Documents.
- I. Do not perform any Work on the Project unless the required insurance policies are in effect. Owner may exclude the Contractor from the Site and exercise Owner's termination rights under the General Conditions if Contractor fails to obtain or maintain the required insurance.
- J. Policies must provide notice before cancellation, non-renewal or any material change in the policy's terms and conditions as described in Paragraph 1.04.D. Contractor is to notify Owner and the additional insured of any notice received within 3 days of receipt of a notice

by Contractor. Contractor is to cease all Work covered by cancelled or non-renewed insurance if suitable coverage is not in place in time to prevent a lapse in coverage. Contractor is solely responsible for any delays associated with lapsed coverage.

- K. Owner may elect, but is in no way obligated, to obtain equivalent insurance to protect Owner's interests without prejudice to any other right or remedy if the Contractor fails to obtain or maintain the required insurance. Owner may impose a reasonable set-off against payments to recover the cost of the insurance.
- L. Owner's policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's policies to meet any of Contractor's obligations to the Owner, Design Professional, or third parties.

1.02 SUBCONTRACTOR OR SUPPLIER INSURANCE

- A. Require Subcontractors to purchase and maintain workers' compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project. Include OPT as additional insureds on Subcontractor's policies in accordance with Paragraph 1.03.
- B. Require Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.
- C. Contractor is liable for all losses that would have been covered by Subcontractor or Supplier insurance if Subcontractor or Supplier fails to provide coverage.

1.03 ADDITIONAL INSURED

- A. The following are to be named as an additional insured on all insurance policies, except workers' compensation insurance, builder's risk insurance, and the Contractor's professional liability insurance:
 - 1. City of Arlington, Texas
Attn: Ashley Brown
Department of Water Utilities
P.O. Box 90231
Arlington, Texas 76004-3231
 - 2. Arcadis U.S., Inc.
630 Plaza Drive, Suite 200
Highlands Ranch, CO 80129
Attention: Risk Management
 - 3. Freese and Nichols, Inc.
801 Cherry Street, Suite 2800
Fort Worth, Texas 76102
Attention: Risk Management
 - 4. Jacobs
1999 Bryan Street, Suite 1200
Dallas, Texas 75201
Attention: Risk Management
- B. All insurance related notices are to be sent to the addresses listed above.

- C. Notify the Owner and additional insured if the Contractor fails to purchase or maintain the insurance required by the Contract Documents.
- D. All insurance policies must include a waiver of subrogation in favor of each additional insured.
- E. Provide for an endorsement that the “other insurance” clause will not apply to the OPT where the OPT is an additional insured. Contractor’s insurance is primary and non-contributory with respect to any insurance or self-insurance carried by the OPT for liability arising out of operations under this Contract.

1.04 EVIDENCE OF INSURANCE

- A. Deliver evidence of insurance, in accordance with this Section, to the Owner with the signed Contract Documents to demonstrate that Contractor has obtained the policies, coverages, and endorsements required by the Contract.
 - 1. Continue to provide evidence Contractor is maintaining the required insurance for the duration of the Contract Times and such extended periods as required by the Contract Documents.
 - 2. Provide this evidence of insurance to Owner and each additional insured.
 - 3. Contractor may block out (redact) any confidential premium or pricing information and wording specific to a project or jurisdiction in any policy or endorsement furnished under this paragraph not applicable to this Contract.
- B. OPT’s failure to demand evidence of insurance or verify the Contractor’s full compliance with insurance requirements or failure to identify a deficiency in compliance from the evidence provided is not a waiver of the Contractor’s obligation to obtain and maintain the insurance required by the Contract Documents
- C. Provide evidence of insurance acceptable to the Owner with the executed Contract Documents. Provide the following as evidence of insurance:
 - 1. Copy of insurance policies;
 - 2. Certificates of insurance on an acceptable form;
 - 3. Full disclosure of exclusions;
 - 4. Declaration pages, riders, or endorsements to policies;
 - 5. Documentation of deductibles;
 - 6. List of named and additional insureds for each policy; and
 - 7. Evidence that waivers of subrogation are provided on applicable policies.
- D. Provide evidence of a requirement in the policy that at least 30 days’ notice will be given before cancellation, and at least 10 days’ notice of non-renewal or any material change in the policy’s terms and conditions including:
 - 1. Type of coverage provided;
 - 2. Riders or endorsements to policies;
 - 3. Policy limits of coverage;

4. Change in deductible amount;
 5. Status of named or additional insured; or
 6. Waivers of subrogation.
- E. Certificates of Insurance:
1. Submit certificates of insurance meeting the applicable requirements of the applicable state department of insurance. No requirement of this Contract may be interpreted as requiring the issuance of a certificate of insurance on a form that has not first been filed with and/or approved by the applicable state department of insurance.
 2. Include the name of the Project in the description of operations box on the certificate of insurance, and the name of each additional insured.
- F. Continuing Evidence of Coverage:
1. Provide updated, revised, or new evidence of insurance prior to the expiration of existing policies. A certificate of insurance on an Acord form, or other State approved form, is acceptable as evidence of renewal of insurance policies, provided no changes are made in the policy originally provided with signed Contract Documents.
 2. Provide evidence of continuation of insurance coverage at final payment and for the following 3 years.
- G. Submit Evidence of Insurance to:
- City of Arlington
Department of Water Utilities
Attention: [Ashley Brown]
P.O. Box 90231
Arlington, Texas 76004-3231

ARTICLE 2 – INSURANCE COVERAGE AMOUNTS AND POLICY REQUIREMENTS

2.01 CONTRACTOR'S INSURANCE

- A. Workers' Compensation and Employer's Liability Insurance:
1. Purchase and maintain workers' compensation and employer's liability insurance, including, as applicable, United States Longshoreman and Harbor Workers' Compensation Act, Jones Act, stop-gap employer's liability coverage for monopolistic states, and foreign voluntary workers' compensation, including off-site operations.
 2. Provide the following coverage with not less than the minimum limits indicated:

Workers' Compensation and Related Insurance	Policy Limits
Workers' Compensation	Statutory Limit
Employers' Liability	
Each Occurrence	\$1,000,000.00
Disease – Each Employee	\$1,000,000.00
Disease - Policy Limit	\$1,000,000.00

B. Commercial General Liability:

1. Purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:
 - a. Damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;
 - b. Damages insured by reasonably available personal injury liability coverage; and
 - c. Damages because of injury to or destruction of tangible property wherever located, including loss of use resulting from the damage.
2. Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form).
 - a. Provide additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). Equivalent endorsements may be used if Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available.
 - b. Provide ISO Endorsement CG 20 32 07 04 "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent for Design Professional additional insured.
3. Provide the following coverages and endorsements:
 - a. Products and completed operations coverage.
 - 1) Maintain coverage for 3 years after final payment.
 - 2) Provide Owner and each other additional insured evidence of continuation of such insurance at final payment and for 3 years thereafter.
 - b. Blanket contractual liability coverage, including coverage of Contractor's contractual indemnity obligations in the General Conditions.
 - c. Severability of interests and no insured-versus-insured or cross-liability exclusions.
 - d. Underground, explosion, and collapse coverage.
 - e. Personal injury coverage.
4. The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:
 - a. Modifications of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).
 - b. Exclusion for water intrusion or water damage.
 - c. Provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
 - d. Exclusion of coverage relating to earth subsidence or movement.

- e. Exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than workers' compensation).
 - f. Limitations or exclusions based on the nature of Contractor's work.
 - g. Professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.
5. Provide the following coverage with not less than the minimum limits indicated:

Commercial General Liability Insurance	Policy Limits
Per Occurrence	\$1,000,000.00
Aggregate	\$2,000,000.00
No standard coverages are to be excluded by endorsement. XCU and contractual liability are not to be excluded	

C. Automobile Liability:

1. Purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis. Coverage can be provided through individual limits for bodily injury and for property damage or a combined single limit covering both bodily injury and property damage.
2. Provide the following coverage with not less than the minimum limits indicated:

Commercial Automobile Liability Insurance	Policy Limits
Combined Single Limit	\$1,000,000.00
Any Auto, including hired, and non-owned autos	

D. Umbrella or Excess Liability:

1. Purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the Paragraphs A through C above. The coverage afforded must be at least as broad as that of each underlying policy.
2. Provide the following coverage with not less than the minimum limits indicated:

Umbrella or Excess Liability Insurance	Policy Limits
Each Occurrence	\$2,000,000.00
Following Form and Drop-down Provisions Included	

E. Contractor's Pollution Liability Insurance:

1. Purchase and maintain a policy covering third-party injury and property damage, including cleanup costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance must be maintained for no less than 3 years after Final Completion.
2. Provide the following coverage with not less than the minimum limits indicated:

Contractor's Pollution Liability Insurance	Policy Limits
Each Occurrence	\$1,000,000.00

Contractor's Pollution Liability Insurance	Policy Limits
General Aggregate	\$2,000,000.00

F. Contractor's Professional Liability Insurance:

1. Purchase and maintain applicable professional liability insurance if Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Contract and for a minimum of 2 years after Substantial Completion. The policy must pre-date the commencement of furnishing services on the Project.
2. Provide the following coverage with not less than the minimum limits indicated:

Contractor's Professional Liability Insurance	Policy Limits
Each Claim	\$1,000,000.00
Annual Aggregate	\$1,000,000.00

G. Unmanned Aerial Vehicle Liability Insurance:

1. Purchase and maintain Unmanned Aerial Vehicle (UAV—commonly referred to as drones) liability insurance if Contractor uses UAV at the Site or in support of any aspect of the Work. Insurance must provide coverage for property damage, bodily injury or death, and invasion of privacy.
2. Provide the following coverage with not less than the minimum limits indicated:

Unmanned Aerial Vehicle Liability Insurance	Policy Limits
Each Claim	\$1,000,000.00
Annual Aggregate	\$1,000,000.00

H. Technology Liability Insurance:

1. Purchase and maintain Technology Liability insurance if Contractor for technology-based services. Insurance must provide coverage for property damage, bodily injury or death.
2. Provide the following coverage with not less than the minimum limits indicated:

Technology Liability	Policy Limits
Each Claim	\$1,000,000.00
Annual Aggregate	\$2,000,000.00
Coverage written on a claims made basis must be maintained for two (2) years after completion of services	

2.02 BUILDER'S RISK INSURANCE

- A. Purchase and maintain builder's risk insurance on a completed value basis in the amount of the Work's full insurable replacement cost.
1. The builder's risk insurance must be written on a builder's risk "all risk" policy form that, at a minimum, includes insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment stored and in transit,

and must not exclude the coverage of the following risks: fire; windstorm; hail; flood; earthquake, volcanic activity, and other earth movement; lightning; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; and water damage (other than that caused by flood).

- a. Policy must include coverage for losses from physical damage or loss with respect to defective workmanship, methods, design, or materials.
 - b. Provide other insurance policies acceptable to Owner if insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake, volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise.
2. The builder's risk insurance must cover, as insured property, at least the following:
 - a. Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property;
 - b. Spare parts inventory required by the Contract; and
 - c. Temporary works which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures but are not intended to form part of the permanent constructed Work.
 3. The builder's risk insurance must be maintained in effect until the Work is complete, or until written confirmation of Owner's procurement of property insurance following Substantial Completion, whichever occurs first.
 4. The builder's risk insurance must:
 - a. Cover expenses incurred in the repair or replacement of any insured property (including fees and charges of contractors, engineers, and architects).
 - b. Allow for the waiver of the insurer's subrogation rights, as set forth in this Contract.
 - c. Allow for partial occupancy or use by Owner by endorsement, and without cancellation or lapse of coverage.
 - d. Include performance/hot testing and startup.
 - e. Cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
 - f. Cover damage or loss to insured property while in transit.

5. The builder's risk insurance must include as named insureds the Owner, Contractor, Subcontractors (of every tier), and any other individuals or entities required by this Contract to be insured under such builder's risk policy.
- B. The builder's risk policy will include, for the benefit of Owner, loss of revenue and soft cost coverage for losses arising from delays in completion that result from covered physical losses or damage. Such coverage will include, without limitation, fixed expenses, and debt service for a minimum of 12 months with a maximum deductible of 30 days, compensation for loss of net revenues, rental costs, and attorneys' fees and engineering or other consultants' fees, if not otherwise covered.

2.03 INSTALLATION FLOATER

- A. Provide and maintain installation floater insurance on a broad form or "all risk" policy providing coverage for materials, supplies, machinery, fixtures, and equipment that will be incorporated into the Work ("Covered Property"). Coverage under the Contractor's installation floater will include loss from covered "all risk" causes (perils) to Covered Property:
 1. of the Contractor, and Covered Property of others that is in Contractor's care, custody, and control;
 2. while in transit to the Site, including while at temporary storage sites;
 3. while at the Site awaiting and during installation, erection, and testing;
 4. continuing at least until the installation or erection of the Covered Property is completed, and the Work into which it is incorporated is accepted by Owner.
- B. The installation floater coverage cannot be contingent on an external cause of risk, or limited to property for which the Contractor is legally liable.
- C. The installation floater coverage will be in an amount sufficient to protect Contractor's interest in the Covered Property. The Contractor will be solely responsible for any deductible carried under this coverage.
- D. This policy will include a waiver of subrogation applicable to Owner, Contractor, Design Professional, all Subcontractors, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them.

2.04 OWNER'S LIABILITY INSURANCE

- A. Contractor is required to provide Owner's Protective Liability Insurance coverage for at least the following amounts, unless greater amounts are required by Laws and Regulations.

Owner's Liability Insurance	
General Aggregate	\$1,000,000.00
Each Occurrence (Bodily Injury and Property Damage)	\$1,000,000.00

END OF SECTION

ARTICLE 1 – REQUIRED NOTICE

1.01 Workers' Compensation Insurance Coverage

A. Definitions:

1. Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the division, or a coverage agreement (DWC Form 81, DWC Form 82, DWC Form 83, or DWC Form 84), showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the project.
2. Duration of the project - includes the time from the beginning of the work on the project until the contractor's/person's work on the project has been completed and accepted by the governmental entity.
3. Persons providing services on the project ("subcontractor" in §406.096) - includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the project, regardless of whether that person contracted directly with the contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project. "Services" does not include activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

- B. The contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all employees of the contractor providing services on the project, for the duration of the project.
- C. The contractor must provide a certificate of coverage to the governmental entity prior to being awarded the contract.
- D. If the coverage period shown on the contractor's current certificate of coverage ends during the duration of the project, the contractor must, prior to the end of the coverage period, file a new certificate of coverage with the governmental entity showing that coverage has been extended.
- E. The contractor shall obtain from each person providing services on a project, and provide to the governmental entity:
 1. a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on the project; and
 2. no later than 7 days after receipt by the contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

- F. The contractor shall retain all required certificates of coverage for the duration of the project and for one year thereafter.
- G. The contractor shall notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.
- H. The contractor shall post on each project site a notice, in the text, form and manner prescribed by the Texas Department of Insurance, Division of Workers' Compensation, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.
- I. The contractor shall contractually require each person with whom it contracts to provide services on a project, to:
 - 1. provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all of its employees providing services on the project, for the duration of the project;
 - 2. provide to the contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;
 - 3. provide the contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;
 - 4. obtain from each other person with whom it contracts, and provide to the contractor:
 - a. a certificate of coverage, prior to the other person beginning work on the project; and
 - b. a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;
 - 5. retain all required certificates of coverage on file for the duration of the project and for one year thereafter;
 - 6. notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and
 - 7. contractually require each person with whom it contracts, to perform as required by paragraphs 1 - 7, with the certificates of coverage to be provided to the person for whom they are providing services.
- J. By signing this contract or providing or causing to be provided a certificate of coverage, the contractor is representing to the governmental entity that all employees of the contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the

division. Providing false or misleading information may subject the contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

- K. The contractor's failure to comply with any of these provisions is a breach of contract by the contractor which entitles the governmental entity to declare the contract void if the contractor does not remedy the breach within ten days after receipt of notice of breach from the governmental entity.

END OF SECTION

ARTICLE 1 – OWNER’S MINORITY/WOMEN BUSINESS ENTERPRISE PARTICIPATION PROGRAM

1.01 Policy and Contract Specific Goal

- A. As of March 30, 2021, the City of Arlington implemented a Minority and/or Woman-Owned Business Enterprise (MWBE) program whereby minority/woman-owned businesses are included in the City’s procurement process for all basic goods and services, construction, and professional services. The City and the Office of Business Diversity will ensure MWBE companies are provided an equal opportunity to compete for all City procurements.
- B. A Contract Specific Goal of 30% of the Contract Price, less Owner’s Contingency Allowance and Extra Work item amounts, has been set for this project. Contractor is required to utilize certified MWBE companies and/or persons for a minimum of 30 % of the Contract Price, less Owner’s Contingency Allowance and Extra Work item amounts. The Contractor’s MWBE commitment percentage is based on the total value of the contract including any change orders and modifications throughout the contract agreement.
- C. The Contract Specific Goal can be met through MWBE prime participation, MWBE subcontractor participation, submission of the good faith efforts documentation or a combination of any of the stated methods. An MWBE prime contractor’s percentage of self-performed work can be counted towards this Contract Specific Goal. If the MWBE prime contractor’s participation falls short of the Contract Specific Goal, the remaining percentage can be met utilizing MWBE subcontractors or the prime’s submittal of the Good Faith Effort’s Checklist and supporting documentation.
- D. The City’s Minority and Woman Business Enterprise Policy and Procedures Manual (hereinafter “MWBE Policy & Procedures Manual”) is incorporated herein by reference as though written word for word. A copy of the MWBE Policy & Procedures Manual can be found at: <https://www.arlingtontx.gov/cms/One.aspx?portalId=14481146&pageId=18054149>

1.02 Post award compliance

- A. The Contractor shall report all subcontractor payment activity with the Contractor’s monthly estimate. Contractor shall submit monthly pay estimate to the City’s Diversity Management System (B2Gnow), including all payments to subcontractors on the Contract no later than 5 business days after City has agreed on quantities in monthly estimate.
- B. If change orders, amendments or any contract modifications are issued by the City, the Contractor has a contractual commitment to meet and/or exceed their MWBE utilization goal. Contractor is obligated to immediately notify the City, in writing, of any agreed increase or decrease in the scope of work that will impact the MWBE participation in the contract.
- C. The Contractor cannot terminate, substitute, or change the terms of the MWBE Utilization Plan prior to or after Contract award without prior written consent from the City. If the Contractor is unable to meet its MWBE commitment with certified MWBE companies, the Contractor shall satisfy its commitment, as it relates to the scope of work changes, modifications, and/or amendments by soliciting new certified MWBE companies. Contractor shall submit a Request for Approval of Change to MWBE Utilization Plan for review and written approval from the City.

- D. If the City observes any MWBE subcontractor other than those listed on the MWBE Utilization Plan are performing work or providing materials and/or equipment for those MWBE Subcontractors listed on the MWBE Utilization Plan, the Contractor will be notified in writing that an apparent violation is taking place and payments may be withheld in addition to any other sanctions included in the MWBE Policy and Procedures Manual. The Contractor will be given an opportunity to meet with the City prior to a finding of noncompliance.
- E. Contractor shall pay its subcontractors no later than the 5th business day after the date the prime contractor receives payment from the City. The prime contractor also agrees to promptly request the release of any retainage withheld from subcontractors within five (5) business days after the subcontractor's work is satisfactorily completed and receives partial acceptance, substantial completion or final completion/final acceptance as defined in the Specifications of the contract. Furthermore, the prime contractor agrees to pay the subcontractor its retainage within five (5) business days after the date the prime contractor receives the subcontractor's retainage payment from the City. A finding of non-payment shall be a material breach of this contract. The City may withhold progress payments until the Contractor demonstrates timely payment due all subcontractors. The City also reserves the right to exercise other breach of contract remedies.
- F. During the performance of this Contract, the Contractor or Subcontractor agrees that it will not discriminate on the basis of on race, age, color, religion, sex, sexual orientation, gender identity, national origin, ancestry, gender, disability, or place of birth in the award. Failure by the Contractor to ensure non-discrimination is a material breach of this Contract, which may result in the termination of this Contract or such other remedy, as the City deems appropriate. The Contractor must insert the substance of this clause in all Subcontracts and purchase orders.
- G. The failure by the Contractor to carry out the requirements of the Program is a material breach of the Contract and may result in the termination of the Contract or such other remedies as the City deems appropriate. Violation of MWBE Policies and Procedures, or Contractual obligations, may result in any one or more of the following sanctions:
 - 1. Administrative Warning: Issued for first-time violations or minor violations.
 - 2. Withholding of funds payable under the Contract, including, but not limited to, funds payable for work self-performed by the Contractor or applicable retainage.
 - 3. Temporarily suspending, at no cost to the City, Contractor's performance under the Contract.
 - 4. Termination of the Contract.
 - 5. Suspension/debarment of a Contractor for a period of time from participating in any solicitations issued by the City.

END OF SECTION

00 73 43 WAGE RATE REQUIREMENTS

ARTICLE 1 – PREVAILING WAGE RATES

1.01 PAYMENT OF PREVAILING WAGE RATES

- A. Contractor and any Subcontractors employed on this Project must pay not less than the rates established by the Owner as required by Texas Government Code Chapter 2258.

1.02 RECORDS

- A. In accordance with Tex. Gov't Code §2258.024, the Contractor and its Subcontractors, if any, shall keep a record showing:
 - 1. The name and occupation of each worker employed by the Contractor or Subcontractor in the construction of the Work; and
 - 2. The actual per diem wages paid to each worker.
- B. The record shall be open at all reasonable hours to inspection by the officers and agents of the Owner.

1.03 LIABILITY; PENALTY; CRIMINAL OFFENSE

- A. Tex. Gov't Code §2258.003 – Liability: An officer, agent, or employee of the Owner is not liable in a civil action for any act or omission implementing or enforcing Chapter 2258 unless the action was made in bad faith.
- B. Tex. Gov't Code §2258.023(b) – Penalty: Any Contractor or Subcontractor who violates the requirements of Chapter 2258, shall pay to the Owner, on whose behalf the Contract is made, \$60 for each worker employed or each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the Contract.
- C. Tex. Gov't Code §2258.058 – Criminal Offense:
 - 1. An officer, agent, or representative of the Owner commits an offense if the person willfully violates or does not comply with a provision of Chapter 2258.
 - 2. Any Contractor or Subcontractor, or an agent or representative of the Contractor or Subcontractor, commits an offense if the person violates Tex. Gov't Code §2258.024.
 - 3. An offense is punishable by:
 - a. A fine not to exceed \$500;
 - b. Confinement in jail for a term not to exceed 6 months; or
 - c. Both a fine and confinement.

1.04 MINIMUM WAGE RATES

- A. The minimum wage rates for various labor classifications as established by the Owner are as shown in Section 00 73 46 "Wage Determination Schedule."

END OF SECTION

00 73 46 WAGE DETERMINATION SCHEDULE

The City of Arlington has adopted the following Prevailing Wage Rates for this project:

General Decision Number: TX20210270 12/17/2021

Superseded General Decision Number: TX20200270

State: Texas

Construction Type: Building

Counties: Tarrant County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories)

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.95 for calendar year 2021 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.95 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2021. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

<u>Modification Number</u>	<u>Publication Date</u>
0	01/01/2021
1	03/12/2021
2	05/07/2021
3	07/02/2021
4	12/17/2021

ASBE0021-011 08/01/2017

Classification	Rates	Fringes
ASBE0021-011 08/01/2017		
Asbestos Worker/Heat & Frost Insulator (Duct, Pipe and Mechanical System Insulation)	25.87	7.23
* BOIL0074-003 01/01/2021		
Boilermaker	29.47	24.10
* CARP1421-002 10/01/2021		
Millwright	27.00	11.08
ELEV0021-006 01/01/2021		
Elevator Mechanic	\$44.02	\$36.365

Classification	Rates	Fringes
ENGI0178-005 06/01/2020		
Power Equipment Operator		
Tower crane	\$32.85	\$13.10
Cranes with pile driving or caisson attachment and hydraulic crane 60 tons and above	\$28.75	\$10.60
Hydraulic cranes 59 tones and under	\$32.32	\$13.10
IRON0263-005 06/01/2020		
Ironworker (Ornamental and Structural	\$25.14	\$7.43
PAIN0053-004 04/01/2014		
Painter (brush, roller, and spray (excludes drywall finishing/taping))	\$16.40	\$5.45
PLUM0146-003 05/01/2021		
Pipefitter (Excludes HVAC pipe installation)	\$34.13	\$9.70
SUTX2014-048 07/21/2014		
Bricklayer	\$20.66	\$0.00
Carpenter, Excludes Drywall Hanging, Form Work, and Metal Stud Installation	\$15.47	\$1.82
Cement Mason/Concrete Finisher	\$13.44	\$0.00
Drywall Finisher/Taper	\$16.24	\$3.94
Drywall Hanger and Metal Stud Installer	\$16.20	\$3.40
Electrician (Alarm Installation Only)	\$18.00	\$0.38
Electrician (Low Voltage Wiring Only)	\$14.88	\$2.15
Electrician (Sound and Communication Systems Only)	\$17.79	\$2.41
Electrician, Excludes Low Voltage Wiring and Installation of Alarms/Sound and Communication Systems	\$20.59	\$3.98
Form Worker	\$12.35	\$0.00
Glazier	\$16.61	\$3.40
HVAC Mechanic (HVAC Unit Installation Only).	\$22.39	\$7.10
Installer - Siding (Metal/Aluminum/Vinyl)	\$15.77	\$0.00
Ironworker, Reinforcing	\$12.19	\$0.00
Laborer: Common or General	\$11.30	\$0.00
Laborer: Mason Tender - Brick	\$10.50	\$0.00
Laborer: Mason Tender - Cement/Concrete	\$10.81	\$0.00
Laborer: Pipelayer	\$13.00	\$0.35
Laborer: Roof Tearoff	\$11.28	\$0.00
Laborer: Landscape and Irrigation	\$10.00	\$0.00
Operator: Backhoe/Excavator/Trackhoe	\$13.09	\$0.00
Operator: Bobcat/Skid Steer/Skid Loader	\$13.93	\$0.00
Operator: Bulldozer	\$18.23	\$1.31
Operator: Drill	\$17.60	\$0.50
Operator: Forklift	\$14.20	\$0.00
Operator: Grader/Blade	\$12.95	\$0.00
Operator: Loader	\$12.89	\$1.19
Operator: Mechanic	\$17.52	\$3.33
Operator: Paver (asphalt, aggregate, and concrete)	\$18.44	\$0.00

Classification	Rates	Fringes
Operator: Roller	\$15.04	\$0.00
Pipefitter (HVAC pipe installation only)	\$21.28	\$4.45
Plasterer	\$15.30	\$0.00
Plumber, excludes HVAC pipe installation	\$22.10	\$4.17
Roofer	\$15.70	\$0.58
Sheet Metal Worker (HVAC duct installation only)	\$21.54	\$5.59
Sheet Metal Worker, Excludes HVAC duct installation	\$18.63	\$0.65
Sprinkler Fitter (fire sprinklers)	\$19.27	\$3.68
Tile Finisher	\$11.22	\$0.00
Tile Setter	\$12.00	\$0.00
Truck Driver: Dump Truck	\$12.39	\$1.18
Truck Driver: Flatbed Truck	\$19.65	\$8.57
Truck Driver: Semi-Trailer Truck	\$12.50	\$0.00
Truck Driver: Water Truck	\$12.00	\$4.11
Welders - Receive rate prescribed for craft performing operation to which welding is incidental.		

END OF SECTION

01_11_00 SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Construct Work as described in the Contract Documents.
 - 1. Provide the materials, equipment, and incidentals required to make the Project completely and fully operable.
 - 2. Provide the labor, equipment, tools, and consumable supplies required for a complete Project.
 - 3. Provide the civil, landscape, architectural, structural, mechanical, plumbing, fire protection, electrical, communication, instrumentation, and all other Work required for a complete and operable Project.
 - 4. Test and place the completed Project in operation.
 - 5. Provide the special tools, spare parts, lubricants, supplies, or other materials as indicated in the Contract Documents for the operation and maintenance of the Project.
 - 6. The Contract Documents do not indicate or describe all Work required to complete the Project. Additional details required for the correct installation of selected products are to be provided by the Contractor and coordinated with the Construction Manager.

1.02 DESCRIPTION OF WORK

- A. Work is described in general, non-inclusive terms as:
 - 1. Main Laboratory and Maintenance Building (Project 1): Single story steel framed building with masonry and metal panel cladding. Roofing consists of standing seam metal roofing and single ply roofing. Building has punched windows and clerestory windows in open lab areas. Interior partitions are gypsum wallboard over metal studs. Laboratory areas included benchtops, casework, and fume hoods. Extensive HVAC exhaust systems and mechanical piping. Administrative areas include enclosed and open office workspaces, training room, break room and restrooms. Maintenance bay includes an office area and an open bay area for light maintenance and storage of supplies.

The anticipated construction time frame for completion of this work is twenty consecutive months from notice to proceed.
 - 2. Mini Laboratory and Admin Building Renovation (Project 2): Interior renovation of the existing second floor mini laboratory and control room; and interior renovation of the existing first floor conference room into offices and meeting room.
 - a. Mini laboratory includes casework and benchtops, plumbing for new sinks and analyzers and new partitions. Mini-Laboratory work is limited to sixty calendar days during which operations staff will maintain access to sinks and analyzers. A 48-hour shut down period is anticipated for relocation of sample lines to new analyzer rack and sample sink. Transition anticipated in mid to late November

2022, coordinate exact dates and times with owner. Contractor is responsible for sequencing and transitioning sample lines within a 4-hour window. Sample lines are to be addressed individually, reference drawings indicating this work.

- b. First floor includes new partitions, ceilings, and relocation of MEP support utilities. These areas will remain in operation during construction and contractor will be required to schedule all construction in advance with the owner. Ongoing operations will be temporarily relocated to adjacent areas and contractor will be required to protect operations and adjacent areas. Work in Control Room E-23 will be limited to 60 calendar days construction.

1.03 WORK UNDER OTHER CONTRACTS

- A. The following items of work are not included in this Contract, but may impact construction scheduling, testing, and startup:

Owner	Description
City of Arlington	Eden Road Construction On-going
City of Arlington	Backwash Improvements Project WUTR 18002 (Anticipated NTP March 2020)

- B. Bring any discrepancies in the list to the attention of the Construction Manager. It will be deemed that the Contractor included the more expensive listing in the Contract Price if the Contractor fails to bring any discrepancies to the attention of the Construction Manager prior to executing the Agreement.
- C. Completion of the Work described in this Contract may impact the construction and testing of the items listed above.
 - 1. Coordinate construction activities through the Construction Manager.
 - 2. Pay claims for damages which result from the late completion of the Project or any specified Milestones.

1.04 WORK BY OWNER

- A. The Owner has no knowledge of work, other than the Work included in this Contract that may impact construction scheduling, testing, and startup.
- B. Bring any discrepancies between the projects listed above and those specified elsewhere in the Contract Documents to the attention of the Construction Manager. It will be deemed that the Contractor included the more expensive listing in the Contract Price if the Contractor fails to bring any discrepancies to the attention of the Construction Manager prior to executing the Agreement.
- C. Completion of the Work described in this Contract may impact the construction and testing of the items listed above.
 - 1. Coordinate construction activities through the Construction Manager.
 - 2. Pay claims for damages which result from the late completion of the Project or any specified Milestones.

- D. Owner will provide normal operation and maintenance of the existing facilities during construction, unless otherwise stated.
- E. Maintaining operations in the mini laboratory and control room areas will be of utmost importance. Coordinate all disruption of services with owner including any owner planned facility shutdowns.

1.05 CONSTRUCTION OF UTILITIES

- A. A new power service will be used for this Project. Coordinate with others performing Work associated with this Project.
- B. Power and Electrical Services:
 - 1. Owner will provide permanent power connections for the Site through the power utility unless indicated otherwise in the Contract Documents.
 - 2. Owner will pay for permits and for providing permanent power.
 - 3. Coordinate and cooperate with others performing this Work.
 - 4. Provide conduit, conductors, pull boxes, manholes, and other appurtenances for the installation of power cable between the property line and the transformer and between the transformer and the main power switch unless the Contract Documents indicate otherwise.
 - 5. Test conductors in accordance with the Specifications and requirements of the power utility and coordinate with the power utility to energize the system when ready.
 - 6. Pay for temporary power including construction cost, meter connection, fees, and permits.
 - 7. Contractor may use the permanent power source in lieu of temporary power source when permanent power is available at the Site.
 - a. Notify Construction Manager and Owner of intent to use the permanent power source.
 - b. Arrange with the power utility and pay the charges for connections and monthly charges for use of this power.
 - 8. Pay for the power consumed until the Project has been accepted as Substantially Complete unless noted otherwise.
- C. Telephone Services:
 - 1. Owner will provide permanent telephone service for the Site through the telephone utility.
 - 2. Owner will pay for providing permanent telephone service.
 - 3. Coordinate and cooperate with others performing this Work.
 - 4. Test all cable and connections in accordance with Specifications and telephone utility requirements and coordinate with the telephone utility to ring out all lines on the system when ready.

5. Pay for temporary service including construction cost, telephones, internet and equipment, connection fees, and permit.
6. Contractor may use the permanent telephone lines in lieu of temporary lines when permanent lines are available at the Site.
7. Notify Construction Manager and Owner of intent to use the permanent telephone system.
8. Arrange with the telephone utility and pay the charges for connections and monthly charges for use of this service.
9. Pay for the service until the Project has been accepted as Substantially Complete. Provide separate service for Owner, Contractor, and Construction Manager.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_26_00 CHANGE MANAGEMENT

PART 1 - GENERAL

1.01 REQUESTS FOR CHANGE PROPOSAL

- A. Construction Manager will initiate Modifications by issuing a Request for Change Proposal (RCP).
 - 1. Construction Manager and Design Professional will prepare a description of proposed Modifications.
 - 2. Construction Manager will issue the Request for Change Proposal form to Contractor. A number will be assigned to the Request for a Change Proposal when issued.
 - 3. Return a Change Proposal in accordance with Paragraph 1.02 for evaluation by the OPT.

1.02 CHANGE PROPOSALS

- A. Submit a Change Proposal (CP) to the Construction Manager for Contractor initiated changes in the Contract Documents or in response to a Request for Change Proposal. Submit the Change Proposal and attach the forms provided by the Construction Manager.
 - 1. Use the Change Proposal form provided by the Construction Manager.
 - 2. Include with the Change Proposal:
 - a. A complete description of the proposed Modification if Contractor initiated or proposed changes to the OPT's description of the proposed Modification.
 - b. The reason the Modification is requested, if not in response to a Request for a Change Proposal.
 - c. A detailed breakdown of the cost of the change if the Modification requires a change in Contract Price. The itemized breakdown is to include:
 - 1) List of materials and equipment to be installed;
 - 2) Man-hours for labor by classification;
 - 3) Equipment used in construction;
 - 4) Consumable supplies, fuels, and materials;
 - 5) Royalties and patent fees;
 - 6) Bonds and insurance;
 - 7) Overhead and profit;
 - 8) Field office costs;
 - 9) Home office cost; and
 - 10) Other items of cost.
 - d. Provide the level of detail outlined in the paragraph above for each Subcontractor or Supplier performing the Work if Work is to be provided by a Subcontractor or

Supplier. Indicate appropriate Contractor mark ups for Work provided through Subcontractors and Suppliers. Provide the level of detail outlined in the paragraph above for self-performed Work.

- e. Submit Change Proposals that comply with the General Conditions for Cost of Work.
 - f. Provide a revised schedule. Show the effect of the change on the Project Schedule and the Contract Times.
- B. Submit a Change Proposal to the Construction Manager to request a Field Order.
 - C. A Change Proposal is required for all substitutions or deviations from the Contract Documents.
 - D. Request changes to products in accordance with Section 01_33_02 Shop Drawings.

1.03 CONSTRUCTION MANAGER WILL EVALUATE THE REQUEST FOR A MODIFICATION

- A. Construction Manager will issue a Modification per the General Conditions if the Change Proposal is acceptable to the Owner. Construction Manager will issue a Change Order or Contract Amendment for any changes in Contract Price or Contract Times.
 - 1. Change Orders and Contract Amendments will be sent to the Contractor for execution with a copy to the Owner recommending approval. A Work Change Directive may be issued if Work needs to progress before the Change Order or Contract Amendment can be authorized by the Owner.
 - 2. Work Change Directives, Change Orders, and Contract Amendments can only be approved by the Owner.
 - a. Work performed on the Change Proposal prior to receiving a Work Change Directive or approval of the Change Order or Contract Amendment is performed at the Contractor's risk.
 - b. No payment will be made for Work on Change Orders or Contract Amendments until approved by the Owner.
- B. Contractor may be informed that the Change Proposal is not approved and construction is to proceed in accordance with the Contract Documents.

1.04 EQUAL NON-SPECIFIED PRODUCTS

- A. The products of the listed manufacturers are to be furnished where the Specifications list several manufacturers and do not specifically list "or equal" or "or approved equal" products. Use of any products other than those specifically listed is a substitution. Follow the procedures in Paragraph 1.05 for a substitution.
- B. Contractor may submit other manufacturers' products that are in full compliance with the Specifications where Specifications list one or more manufacturers followed by the phrase "or equal" or "or approved equal."
 - 1. Submit a Shop Drawing as required by Section 01_33_02 Shop Drawings to document that the proposed product is equal or superior to the specified product.

2. Prove that the product is equal. It is not the OPT's responsibility to prove the product is not equal.
 - a. Indicate on a point-by-point basis for each specified feature that the product is equal to the Contract Document requirements.
 - b. Make a direct comparison with the specified manufacturer's published data sheets and available information. Provide this printed material with the Shop Drawing.
 - c. The decision of the Design Professional regarding the acceptability of the proposed product is final.
3. Provide a certification that, in furnishing the proposed product as an equal, the Contractor:
 - a. Has thoroughly examined the proposed product and has determined that it is equal or superior in all respects to the product specified.
 - b. Has determined that the product will perform in the same manner and result in the same process as the specified product.
 - c. Will provide the same warranties and/or bonds as for the product specified.
 - d. Will assume all responsibility to coordinate any modifications that may be necessary to incorporate the product into the construction and will waive all claims for additional Work which may be necessary to incorporate the product into the Project which may subsequently become apparent.
 - e. Will maintain the same time schedule as for the specified product.
- C. A Change Proposal is not required for any product that is in full compliance with the Contract Documents. If the product is not in full compliance, it may be offered as a Substitution.

1.05 SUBSTITUTIONS

- A. Substitutions are defined as any product that the Contractor proposes to provide for the Project in lieu of the specified product. Submit a Change Proposal per Paragraph 1.02 along with documents required for a Shop Drawing as required by Section 01_33_02 Shop Drawings to request approval of a substitution.
- B. Prove that the product is acceptable as a substitute. It is not the Design Professional's responsibility to prove the product is not acceptable as a substitute.
 1. Indicate on a point-by-point basis for each specified feature that the product is acceptable to meet the intent of the Contract Documents requirements.
 2. Make a direct comparison with the specified Suppliers published data sheets and available information. Provide this printed material with the Shop Drawing.
 3. The decision of the Design Professional regarding the acceptability of the proposed substitute product is final.

- C. Provide a certification that, in making the substitution request, the Contractor:
1. Has determined that the substituted product will perform in substantially the same manner and result in the same ability to meet the specified performance as the specified product;
 2. Will provide the same warranties and/or bonds for the substituted product as specified or as would be provided by the manufacturer of the specified product;
 3. Will assume all responsibility to coordinate any modifications that may be necessary to incorporate the substituted product into the Project and will waive all claims for additional Work which may be necessary to incorporate the substituted product into the Project which may subsequently become apparent; and
 4. Will maintain the same time schedule as for the specified product.
- D. Pay for review of substitutions in accordance with Section 01_33_02 Shop Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_29_00 APPLICATION FOR PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Submit Applications for Payment for completed Work and for materials and equipment in accordance with the General Conditions, the Supplementary Conditions, the Agreement, and this Section. The Contract Price is to include costs for:
1. Providing the Work in accordance with the Contract Documents;
 2. Installing Owner furnished equipment and materials, if any;
 3. Providing Work for alternates and allowances, if any;
 4. Providing Work for extra work Items, if any, and if authorized
 5. Commissioning, startup, training, and initial maintenance and operation;
 6. Acceptance testing at the manufacturer's facilities or at the Site;
 7. All home office overhead costs and expenses, including profit made directly or indirectly from the Project;
 8. Project management, contract administration, and field office and field operations staff including supervision, clerical support, and technology system support;
 9. Professional services including design fees, legal fees, and other professional services incurred by the Contractor to perform its work;
 10. Bonds and insurance;
 11. Permits, licenses, patent fees, and royalties;
 12. Taxes;
 13. Providing all documentation and Samples required by the Contract Documents;
 14. Facilities and equipment at the Site including:
 - a. Field offices, office furnishings, and all related office supplies, software, and equipment,
 - b. Storage facilities for Contractor's use and storage facilities for stored materials and equipment including spare parts storage,
 - c. Shops, physical plant, construction equipment, small tools, vehicles, and technology and telecommunications equipment,
 - d. Safety equipment and facilities to provide safe access and working conditions for workers and for others working at the Site,
 - e. Temporary facilities for power and communications,
 - f. Potable water and sanitation facilities, and
 - g. Mobilization and demobilization for all these facilities and equipment.

15. Products, materials, and equipment stored at the Site or other suitable location in accordance with Section 01 31 00 "Project Management and Coordination";
 16. Products, materials, and equipment permanently incorporated into the Project;
 17. Temporary facilities for managing water including facilities for pumping, storage, and treatment as required for construction and protection of the environment;
 18. Temporary facilities for managing environmental conditions and Constituents of Concern;
 19. Temporary facilities such as sheeting, shoring, bracing, formwork, embankments, storage facilities, working areas, and other facilities required for construction of the Project;
 20. Temporary and permanent facilities for protection of all overhead, surface, or underground structures or features;
 21. Temporary and permanent facilities for removal, relocation, or replacement of any overhead, surface, or underground structures or features;
 22. Products, materials, and equipment consumed during the construction of the Project;
 23. Contractor labor and supervision to complete the Project including that provided through Subcontractors or Suppliers;
 24. Correcting Defective Work during the Contract Times, during the Correction Period, or as required to meet any warranty provision of the Contract Documents;
 25. Risk associated with weather and environmental conditions, startup, and initial operation of facilities including equipment, processes, and systems;
 26. Contractor safety programs, including management, administration, and training;
 27. Maintenance of facilities including equipment, processes, and systems until operation is transferred to Owner;
 28. Warranties, extended or special warranties, or extended service agreements;
 29. Cleanup and disposal of any and all surplus materials; and
 30. Demobilization of all physical, temporary facilities not incorporated into the Project.
- B. Include the cost not specifically set forth as an individual payment item but required to provide a complete and functional system in the Contract Price.
- C. Provide written approval of the surety company providing performance and payment bonds for the Schedule of Values, Application for Payment form, and method of payment prior to submitting the first Application for Payment. Submit approval using the "Consent of Surety Company to Payment Procedures" form provided by the Construction Manager. Payment will not be made without this approval.
- D. Construction Manager may withhold processing the Applications for Payment if any of the following processes or documentation is not up to date:
1. Progress Schedule per Section 01_33_05 Construction Schedules.
 2. Record Documents per Section 01_31_13 Project Coordination.

3. Documentation required to comply with Section 00_73_39 Minority/Women Business Participation Program.

1.02 SCHEDULE OF VALUES

- A. Divide the Contract Price into an adequate number of line items to allow more accurate determination of the earned value for each line item when evaluating progress payments. Submit a detailed Schedule of Values for the Project at least 10 days prior to submitting the first Application for Payment using forms provided by the Construction Manager.
- B. Do not apply for payment until the Schedule of Values has been approved by the Construction Manager.
- C. Divide the cost associated with each line item in the Schedule of Values into installation and materials components.
 1. Installation cost is to include all cost associated with the line item except materials cost.
 2. Materials cost is the direct cost (as verified by invoice values) for products, materials, and equipment to be permanently incorporated into the Project associated with the line item.
 3. Installation cost is to include all direct costs and a proportionate amount of the indirect costs for the Work associated with each line item. Include costs not specifically set forth as an individual payment item but required to provide a complete and functional system.
 4. The sum of materials and installation costs for all line items must equal the Contract Price.
- D. Use each unit price line item in the Agreement as a line item in the Schedule of Values. The sum of materials and installation costs for each line item for unit price contracts must equal the value of the line item in the Agreement. In addition to the installation cost described in Paragraph 1.02.C.3, installation costs for unit price items are to include costs for waste and overages.
- E. Breakdown of Lump Sum and Unit Price Items
 1. Installation and materials cost may be left as a single installation component if:
 - a. Contractor does not intend to request payment for stored materials for that line item; or
 - b. Work in the line item will be completed within a single payment period.
 2. Provide adequate detail to allow a more accurate determination of the earned value for installation costs, expressed as a decimal fraction of Work completed, for each line item.
 3. Installation cost line items may not exceed \$50,000.00. Items that are not subdivided into smaller units may only be included in the Application for Payment when Work on the entire unit is complete.

4. Lump sum items may be divided into an estimated number of units to estimate earned value. The estimated number of units times the cost per unit must equal the lump sum amount for that line item.
 5. Include Contractor's overhead and profit in the installation costs each line item in proportion to the value of the line item to the Contract Price.
 6. Include cost not specifically set forth as an individual payment item but required to provide a complete and functional system in the Contract Price for each item.
 7. Line items may be used to establish the value of Work to be added or deleted from the Project.
- F. Include a breakdown of both mobilization and demobilization costs in the Schedule of Values. The total cost for both mobilization and demobilization may not exceed 5 percent of the total Contract Price. Payment for mobilization and demobilization will be based on the earned value of Work completed for the following.
1. Bonds and insurance;
 2. Transportation and setup for equipment;
 3. Transportation and/or erection of all field offices, sheds and storage facilities;
 4. Salaries for preparation of documents required before the first Application for Payment; and
 5. Salaries for field personnel directly related to the mobilization of the Project.

1.03 SCHEDULE OF ANTICIPATED PAYMENTS

- A. Submit a schedule of the anticipated Application for Payments showing the anticipated application numbers, submission dates, and the amount to be requested for each Application for Payment on the form provided by the Construction Manager.
- B. Update the schedule of anticipated payments as necessary to provide a reasonably accurate indication of the funds required to make payments each month to the Contractor for Work performed.

1.04 ALTERNATES, ALLOWANCES, AND EXTRA WORK ITEMS

- A. Include line items and amounts for specified alternate Work and allowances for Work in the Agreement, if any.
- B. Include line items and amounts for Extra Work items in the Agreement, if any.

1.05 RETAINAGE AND SET-OFFS

- A. Retainage will be withheld from each Application for Payment per the Agreement.
- B. Reduce payments for set-offs per the General Conditions as directed by the Construction Manager.

1.06 PROCEDURES FOR SUBMITTING AN APPLICATION FOR PAYMENT

- A. Submit a draft Application for Payment to the Construction Manager each month at least 10 days before the date established in the Agreement for Owner to make progress payments. Do not submit Applications for Payment more often than monthly. Review the draft Application for Payment with the Construction Manager to determine concurrence with:
 - 1. Values requested for materials and equipment, stored, or incorporated into the Project as documented by invoices;
 - 2. The earned value for installation costs for each line item in the Application for Payment form expressed as a percent complete for that line item;
 - 3. The quantity of Work completed for each unit price item;
 - 4. Amount of retainage to be held; and
 - 5. Set-offs included in the Application for Payment.
- B. Submit Applications for Payment to the Construction Manager after agreement has been reached on the draft Application for Payment with the Construction Manager.
- C. Provide all information requested in the Application for Payment form. Do not leave any blanks incomplete. If information is not applicable, enter "N/A" in the space provided.
 - 1. Number each application sequentially and include the dates for the application period.
 - 2. Complete the "Contract Time Summary" on the Application for Payment form. If "Days Final Completion is (ahead/behind) Schedule" (line q) shows Project is more than 30 days behind schedule, revise the Schedule of Anticipated Payments to correspond to the updated schedule required per Section 01_33_05 "Construction Schedules."
 - 3. Complete the "Summary of Earned Value and Set-offs" on the Application for Payment form. Show the total amounts for earned value of original Contract performed, earned value for Work on approved Contract Amendments and Change Orders, retainage and set-offs.
 - 4. Sign and date the Contractor's Certification on the Application for Payment form that all Work, including materials, covered by this Application for Payment have been completed or delivered and stored in accordance with the Contract Documents, that all amounts have been paid for Work, materials, and equipment for which previous Payment has been made by the Owner, and that the current payment amount shown in this Application for Payment is now due.
 - 5. Include "Attachment A - Tabulation of Earned Value of Original Contract Performed" to show the value of materials stored and successfully incorporated into the Project and the earned value for installation of the Work for each line item in the Application for Payment for Work. Attachment A includes Work on the original Contract Price and on approved Contract Amendments and Change Orders.
 - 6. Include "Attachment B - Tabulation of Values for Materials and Equipment" to track invoices used to support amounts requested as materials in Attachment A. Enter materials to show the amount of the invoice assigned to each item in Attachment A if an invoice includes materials used on several line items.

7. Include "Attachment C - Summary of Set-offs" to document set-offs made per the Contract Documents. Show each set-off as it is applied. Show a corresponding line item to reduce the set-off amount if a payment held by a set-off is released for payment.
 8. Include "Attachment D - Retainage Calculation" to show method for calculating retainage. The amount of retainage with respect to progress payments is stipulated in the Agreement. Any request for a reduction in retainage must be accompanied by a Consent of Surety to Reduction or Partial Release of Retainage.
 9. Include "Attachment E - EVA Calculation" and the EVA Chart showing the anticipated and actual Total Earned Value of Fees, Work, and Materials. Create a graphic representation (curve) of the anticipated progress on the Project each month. Compare the anticipated cumulative Total Earned Value of Fees, Work, and Materials to the actual Total Earned Value of Fees, Work, and Materials to determine performance on budget and schedule. Adjust the table and curve to incorporate Modifications.
- D. Submit attachments in Portable Document Format (PDF).
1. Generate attachments to the Application for Payment using the Excel spreadsheet provided by the Construction Manager.
 2. Submit PDF documents with adequate resolution to allow documents to be printed in a format equivalent to the document original. Documents are to be scalable to allow printing on standard 8-1/2 x 11 or 11 x 17 paper.

1.07 ADJUSTMENTS TO THE SCHEDULE OF VALUES IN THE APPLICATION FOR PAYMENT

- A. Submit a Change Proposal to request any changes to the Schedule of Values incorporated into the Application for Payment once approved. A Field Order will be issued by the Construction Manager to modify the Application for Payment form if approved.
- B. Payment for materials and equipment shown in the Application for Payment will be made for the total of associated invoice amounts, up to the value shown for materials in the Application for Payment for that line item.
 1. If the total amount for invoices for materials and equipment for a line item are less than the amount shown for the materials component of that line item in the Application for Payment, and it can be demonstrated that no additional materials or equipment are required to complete Work described in that item, the difference between the total invoice for materials and equipment and the materials component for that line item can be added to the installation component of that Work item.
 2. Costs for material and equipment in excess of the value shown in the Schedule of Values may not be paid for under other line items.

1.08 CONSTRUCTION MANAGER'S RESPONSIBILITY

- A. Construction Manager will review each draft Application for Payment with Contractor to reach an agreement on the amount to be recommended to Owner for payment. Contractor is to revise the Application for Payment to incorporate changes, if any, resulting from this review process.

- B. Construction Manager will review the Application for Payment to determine that the Application for Payment has been properly submitted and is in accordance with the agreed to draft Application for Payment.
- C. Construction Manager will either recommend payment of the Application for Payment to Owner or notify the Contractor of the reasons for not recommending payment. Contractor may make necessary corrections and resubmit the Application for Payment. Construction Manager will review resubmitted Application for Payment and reject or recommend payment of the Application for Payment to Owner as appropriate.
- D. Construction Manager's recommendation of the Application for Payment constitutes a representation that based on its experience and the information available:
 - 1. The Work has progressed to the point indicated;
 - 2. The quality of the Work is generally in accordance with the Contract Documents; and
 - 3. Requirements prerequisite to payment have been met.
- E. This representation is subject to:
 - 1. Further evaluation of the Work as a functioning whole.
 - 2. The results of subsequent tests called for in the Contract Documents.
 - 3. Any other qualifications stated in the recommendation.
- F. Construction Manager does not represent by recommending payment that:
 - 1. Inspections made to check the quality or the quantity of the Work as it was performed were exhaustive or extended to every aspect of the Work in progress; or
 - 2. Other matters or issues that might entitle Contractor to additional compensation or entitle Owner to withhold payment to Contractor exist.
- G. Neither Construction Manager's review of Contractor's Work for the purposes of recommending payments nor Construction Manager's recommendation of payment imposes responsibility on the Construction Manager or Owner:
 - 1. To supervise, direct, or control the Work;
 - 2. For the means, methods, techniques, sequences, or procedures of construction, or safety precautions and programs;
 - 3. For Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
 - 4. To make examinations to ascertain how or for what purposes Contractor has used the monies paid on account of the Contract Price; or
 - 5. To determine that title to the Work, materials, or equipment has passed to Owner free and clear of Liens.

1.09 FINAL APPLICATION FOR PAYMENT

- A. Include adjustments to the Contract Price per Paragraph B in the final Application for Payment for:
 - 1. Approved Change Orders and Contract Amendments;

2. Allowances not previously adjusted by Change Order;
 3. Deductions for Defective Work that have been accepted by the Owner;
 4. Penalties and bonuses;
 5. Deduction for all final set-offs; and
 6. Other adjustments if needed.
- B. Construction Manager will prepare a final Change Order reflecting the approved adjustments to the Contract Price which have not been covered by previously approved Change Orders and, if necessary, to reconcile estimated unit price quantities with actual quantities.
- C. Submit the final Application for Payment per the General Conditions, including the final Change Order. Provide the following with the final Application for Payment:
1. Evidence of payment or release of Liens on the forms provided by the Construction Manager and as required by the General Conditions.
 2. Consent from surety to final payment.
- D. Final payment will also require additional procedures and documentation per Section 01_70_00 "Execution and Closeout Requirements."

1.10 PAYMENT BY OWNER

- A. Owner is to pay the amount recommended for monthly payments within 30 days after receipt of the Construction Manager's recommended Application for Payment.
- B. Final payment may take longer than 30 days to process a final application for payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_31_00 PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish resources required to complete the Project in accordance with the Contract Documents and within the Contract Times.
- B. Construct Project in accordance with current safety practices.
- C. Manage Site to allow access to Site and control construction operations. Coordinate site access with the Owners. Construction site to be fenced to outside of the plant perimeter.
- D. Construct temporary facilities to provide and maintain control over environmental conditions at the Site. Remove temporary facilities when no longer needed.
- E. Provide temporary controls for pollution, management of water, and management of excess earth as required in Section 01_57_00 Temporary Controls.

1.02 STANDARDS

- A. Perform Work to comply with:
 - 1. Requirements of the Contract Documents;
 - 2. Laws and Regulations; and
 - 3. Specified industry standards.

1.03 DOCUMENTATION

- A. Provide documents in accordance with Section 01_33_00 Document Management.
- B. Provide copies of Supplier's printed storage instructions prior to furnishing materials or products and installation instructions prior to beginning the installation.
- C. Incorporate field notes, sketches, recordings, and computations made by the Contractor in Record Drawings per Section 01_31_13 Project Coordination.

1.04 PERMITS

- A. Obtain building permits for the Project from the local authorities having jurisdiction. Pay building permit fees and include these costs in the Contract Price.
- B. Obtain environmental permits required for construction at the Site.
- C. Provide required permits for transporting heavy or oversized loads.
- D. Provide other permits required to conduct any part of the Work.
- E. Arrange for inspections and certification by agencies having jurisdiction over the Work and include the cost for these inspections and certifications in the Contract Price.
- F. Make arrangements with private utility companies and pay fees associated with obtaining services or inspections.

- G. Retain copies of permits and licenses at the Site and comply with all regulations and conditions of the permit or license.

1.05 SAFETY REQUIREMENTS

- A. Manage safety to protect the safety and welfare of persons at the Site.
- B. Provide safe access to move through the Site. Provide protective devices to warn and protect from hazards at the Site.
- C. Provide safe access for those performing tests and inspections.
- D. Maintain a supply of personal protective equipment for visitors to the Site.
- E. Comply with latest provisions of the Occupational Health and Safety Administration (OSHA) and other Laws and Regulations.
- F. Cooperate with accident investigations. Provide two copies of all reports, including insurance company reports, prepared concerning accidents, injuries, or deaths related to the Project to the Construction Manager as Record Data per Section 01_31_13 Project Coordination.

1.06 ACCESS TO THE SITE

- A. Maintain access to the facilities at all times. Do not obstruct roads, pedestrian walks, or access to the various buildings, structures, stairways, or entrances. Provide safe access for normal operations during construction.
- B. Provide adequate and safe access for inspections. Leave ladders, bridges, scaffolding, and protective equipment in place until inspections have been completed. Construct additional safe access if required for inspections.
- C. Use roadways for construction traffic only with written approval of the appropriate representatives of each entity. Roadways may not be approved for construction traffic. Obtain written approval to use roads to deliver heavy or oversized loads to the Site. Furnish copies of the written approvals to the Construction Manager as Record Data per Section 01_31_13 Project Coordination.

1.07 CONTRACTOR'S USE OF THE SITE

- A. Limit the use of Site for Work and storage to those areas designated on the Drawings or approved by the Construction Manager. Coordinate the use of the Site with the Construction Manager.
- B. Provide security at the Site:
 - 1. Maintain fencing around the Site and lock all gates when not in use.
 - 2. Implement and maintain a security identification system and prevent access by any individuals not authorized to enter the Site. Require personnel to follow and adhere to established policies for entering, remaining on, and exiting the Work Site.
 - 3. Provide security for existing facilities (operating or not), Work in place, stored materials, and Contractors equipment, tools, and materials to protect against vandalism and loss by theft.

4. Maintain the security program throughout duration of the Contract.
 5. The security measures described in this Section are minimum requirements. Provide additional security measures if Site conditions and history warrant additional security measures.
- C. Park construction equipment in designated areas only and provide spill control measures as discussed in Section 01_57_00 Temporary Controls.
 - D. Park employees' vehicles in designated areas only.
 - E. Obtain written permission of the property owner before entering privately-owned land outside of the Owner's property, rights-of-way, or easements.
 - F. Cooperate with public and private agencies with facilities operating within the limits of the Project. Provide 48 hours' notice to any applicable agency when Work is anticipated to proceed in the vicinity of any facility by using the City of Arlington Line Locate Process online for Arlington Water Utility lines and Texas one-call system at 811 or 1-800-344-8377 or 1-888-313-4747.
 - G. Conduct of Contractor's or Subcontractor's Employees:
 1. Do not permit alcoholic beverages or illegal substances on the Site. Do not allow persons under the influence of alcoholic beverages or illegal substances to enter or remain on the Site at any time. Persons on Site under the influence of alcoholic beverages or illegal substances will be permanently prohibited from returning to the Site. Criminal or civil penalties may also apply.
 2. Do not allow the use of offensive language or sexual harassment in any form. These actions will cause immediate and permanent removal of the offender from the premises. Criminal or civil penalties may apply.
 3. Require workers to wear clothing that is inoffensive and meets safety requirements. Do not allow sleeveless shirts, shorts, or any exceedingly torn, ripped, or soiled clothing to be worn on the Site.
 4. Do not allow the use, possession, concealment, transportation, promotion, or sale of the following prohibited items anywhere on the Site:
 - a. Firearms (including air rifles and pistols and BB or pellet guns) and ammunition;
 - b. Bows, crossbows, arrows, bolts, or any other projectile weapons;
 - c. Explosives of any kind, including fireworks;
 - d. Illegal knives;
 - e. Other weapons prohibited by state Laws and Regulations; and
 - f. Any other item that has been designed or intended to be used as a weapon.

No exceptions will be made for the possession of a firearm by a person that has a valid state-issued license to carry a firearm. Remove any of the prohibited items listed above from the Site immediately and permanently. Any person found to be in possession of any prohibited item must also be removed from the Site and may be reported to local law enforcement.

1.08 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. Examine the Site and review the available information concerning the Site. Locate utilities, underground facilities, and existing structures. Verify the elevations of the structures adjacent to excavations. Report any discrepancies from information in the Contract Documents to the Construction Manager before beginning construction.
- B. Determine if existing structures, poles, piping, or other utilities at excavations will require relocation or replacement. Prepare a Plan of Action per Section 01_31_13 Project Coordination. Coordinate Work with local utility company and others for the relocation or replacement.
- C. Protect utilities, underground facilities and existing structures unless they are shown to be replaced or relocated on the Drawings. Restore damaged items to the satisfaction of the Owner and utility or property owner.
- D. Carefully support and protect all structures and/or utilities so that there will be no failure or settlement where excavation or demolition endangers adjacent structures and utilities. Do not take existing utilities out of service unless required by the Contract Documents or approved by the Construction Manager. Notify and cooperate with the utility owner if it is necessary to move services, poles, guy wires, pipelines, or other obstructions.
- E. Protect existing trees and landscaping at the Site. Mark trees that may be removed during construction and review with the Construction Manager for approval before removing. Protect trees to remain from damage limiting activity, including stockpiling of materials within the drip line of the tree.
- F. Protect buildings from damage when handling material or equipment. Protect finished surfaces, including floors, doors, and jambs. Remove doors and install temporary wood protective coverings over jambs, if needed.

1.09 DISRUPTION TO SERVICES/CONTINUED OPERATIONS

- A. Owner's facilities are to continue in service as usual during the construction unless noted otherwise. Owner or utilities must be able to operate and maintain the facilities. Keep disruptions to existing utilities, piping, process piping, or electrical services to a minimum.
 - 1. Do not restrict access to critical valves, operators, or electrical panels.
 - 2. Do not store material or products inside structures unless authorized by the Construction Manager.
 - 3. Limit operations to the minimum amount of space needed to complete the specified Work.
 - 4. Maintain storm sewers and sanitary sewers in service at all times. Provide temporary service around the construction or otherwise construct the Work in a manner that flow is not restricted.
- B. Provide a Plan of Action in accordance with Section 01_35_00 Special Procedures if facilities must be taken out of operation.

1.10 FIELD VERIFICATION

- A. Perform complete field measurements prior to purchasing products or beginning construction for products required to fit existing conditions.
- B. Verify property lines, control lines, grades, and levels indicated on the Drawings.
- C. Verify pipe class, equipment capacities, existing electrical systems, and power sources for existing conditions.
- D. Check Shop Drawings and indicate the actual dimensions available where products are to be installed.
- E. Include field measurements in Record Documents as required in Section 01_31_13 Project Coordination.

1.11 REFERENCE DATA AND CONTROL POINTS

- A. Construction Manager will provide the following control points:
 - 1. Base line or grid reference points for horizontal control.
 - 2. Benchmarks for vertical control.
- B. Locate and protect control points prior to starting the Work and preserve permanent reference points during construction. Designated control points may be on an existing structure or monument. Do not change or relocate points without prior approval of the Construction Manager. Notify Construction Manager when a reference point is lost, destroyed, or requires relocation. Replace Project control points on the basis of the original survey. Control points or benchmarks damaged, disturbed or destroyed as a result of the Contractor's negligence will be restored by the Construction Manager. Owner will impose a set-off as compensation for the effort required.
- C. Provide complete engineering layout of the Work needed for construction.
 - 1. Provide competent personnel. Provide equipment including accurate surveying instruments, stakes, platforms, tools, and materials.
 - 2. Provide surveying with accuracy meeting the requirements established for Texas Board of Professional Engineers and Land Surveyors.
 - 3. Provide Record Data per Section 01_31_13 Project Coordination and measurements per standards.

1.12 DELIVERY AND STORAGE

- A. Deliver products and materials to the Site in time to prevent delays in construction.
- B. Deliver packaged products to Site in original undamaged containers with identifying labels attached. Open cartons as necessary to check for damage and to verify invoices. Reseal cartons and store properly until used. Leave products in original packages or other containers until installed. If original packages or containers are damaged, repackage in containers and include packing slips, labels and other information from the original packaging.

- C. Deliver products that are too large to fit through openings to the Site in advance of the time enclosing walls and roofs are erected. Set in place, raised above floor on cribs or pallets.
- D. Assume full responsibility for the protection and safekeeping of products stored at the Site.
- E. Store products at locations acceptable to the Construction Manager and to allow Owner access to maintain and operate existing facilities.
- F. Store products in accordance with the Supplier's storage instructions immediately upon delivery. Leave seals and labels intact. Arrange storage to allow access for maintenance of stored items and for inspection. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.
- G. Provide additional storage areas as needed for construction. Store products subject to damage by elements in substantial weather-tight enclosures or storage sheds. Provide and maintain storage sheds as required for the protection of products. Provide temperature, humidity control, and ventilation within the ranges stated in the Supplier's instructions. Remove storage facilities at the completion of the Project.
- H. Protect the pipe interior. Keep all foreign materials such as dirt, debris, animals, or other objects out of the pipe during the Work.
- I. Provide adequate exterior storage for products that may be stored out-of-doors.
 - 1. Provide substantial platforms, blocking, or skids to support materials and products above ground which has been sloped to provide drainage. Protect products from soiling or staining.
 - 2. Cover products subject to discoloration or deterioration from exposure to the elements, with impervious sheet materials. Provide ventilation to prevent condensation below covering.
 - 3. Store loose, granular materials on clean, solid surfaces, or on rigid sheet materials, to prevent mixing with foreign matter.
 - 4. Provide surface drainage to prevent erosion and ponding of water.
 - 5. Prevent mixing of refuse or chemically injurious materials or liquids with stored materials.
 - 6. Pipes and conduits stored outdoors are to have open ends sealed to prevent the entrance of dirt, moisture, and other injurious materials. Protect PVC pipe from ultraviolet light exposure.
 - 7. Store products to prevent wind damage.
- J. Protect and maintain mechanical and electrical equipment in storage.
 - 1. Provide Supplier's service instructions on the exterior of the package.
 - 2. Service equipment on a regular basis as recommended by the Supplier. Maintain a log of maintenance services. Submit the log as Record Data per Section 01_31_13 Project Coordination when Owner assumes responsibility for maintenance and operation.
 - 3. Provide power to and energize space heaters for all equipment for which these devices are provided.

4. Provide temporary enclosures for all electrical equipment, including electrical systems on mechanical devices. Provide and maintain heat in the enclosures until equipment is energized.
- K. Maintain storage facilities. Inspect stored products on a weekly basis and after periods of severe weather to verify that:
 1. Storage facilities continue to meet specified requirements;
 2. Supplier's required environmental conditions are continually maintained; and
 3. Products that can be damaged by exposure to the elements are not adversely affected.
- L. Replace any stored item damaged by inadequate protection or environmental controls.
- M. Payment may be withheld for any products not properly stored.

1.13 CLEANING DURING CONSTRUCTION

- A. Provide positive methods to minimize raising dust from construction operations and provide positive means to prevent air-borne dust from discharging into the atmosphere. Control dust and dirt from demolition, cutting, and patching operations.
- B. Clean the Site as Work progresses and dispose of waste materials, keeping the Site free from accumulations of waste or rubbish. Provide containers at the Site for waste collection. Do not allow waste materials or debris to blow around or off of the Site. Control dust from waste materials. Transport waste materials with as few handlings as possible.
- C. Comply with Laws and Regulations. Do not burn or bury waste materials. Remove waste materials, rubbish, and debris from the Site and legally dispose of these at public or private disposal facilities.
- D. Sweep roads where contractor activities require hauling or disturbing earth resulting in dust, soil, rocks, or construction debris at the end of each day. Use magnetic sweeper to gather metals which may be on roads. Sweep all plant roads weekly to provide general maintenance.

1.14 MAINTENANCE OF ROADS, DRIVEWAYS, AND ACCESS

- A. Maintain roads and streets in a manner that is suitable for safe operations of public vehicle during all phases of construction unless the Owner approves a street closing. Do not close public roads overnight. Coordinate and arrange for emergency vehicle access when streets are to be closed.
- B. Submit a Notification by Contractor for Owner's approval of a street closing. The request must state:
 1. The reason for closing the street.
 2. How long the street will remain closed.
 3. Procedures to be taken to maintain the flow of traffic.
- C. Obtain permits and permissions of the entity that owns the road prior to any Work and provide a copy of the permit or permission Record Data per Section 01_31_13 Project Coordination.

- D. Construct temporary detours, including by-pass roads around construction, with adequately clear width to maintain the free flow of traffic at all times. Maintain barricades, signs, and safety features around the detour and excavations. Maintain barricades, signs, and safety features around the Work in accordance with all provisions of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).
- E. Assume responsibility for any damage resulting from construction along roads or drives.

1.15 MAINTENANCE OF WATER TREATMENT PLANT ROADS AND ACCESS

- A. Maintain plant roads and streets in a manner that allows safe operation of all vehicles during construction unless the OPT specifically approves a temporary street closing or temporary blocking of chemical delivery points.
- B. Construct temporary detours, including by-pass roads around construction, with adequately clear width to always maintain the free flow of traffic if alternate routes to destination points are not available. Maintain barricades, signs, and safety features around the detour and excavations. Maintain barricades, signs, and safety features around the Work in accordance with all provisions of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD). Provide flaggers with appropriate with appropriate signs and equipment for high traffic areas or areas where equipment is underway with heavy equipment.
- C. Coordinate and arrange for emergency vehicle access to both operations areas and construction areas at all times. Include access routes in both the Contractor's Site Safety Plan and Traffic Plan.
- D. Provide vehicle access to plant operations and maintenance staff at all times so routine operation and maintenance are not impeded. Do not leave vehicles unattended that might block access to valves, appurtenances, access points such as doors, stair ways or access hatches unless OWNER is notified and approves the temporary position of the vehicle.
- E. Park Contractor construction equipment and employee vehicles only in designated areas shown in the Contract Documents or as approved by the OPT.
- F. Limit access to the plant site for Contractor's staff and deliveries to the Contractor's designated gate.
- G. Provide temporary signage to direct both Contractor and Owner traffic to destination points. Signs are to include the name of the destination point, direction arrows at each road intersection and at each turn, and a sign for the specific destination if not readily apparent. Remove signs when no longer required.
- H. Provide an onsite escort of any Contractor vehicle making deliveries of materials or equipment beyond designated storage areas.
- I. Provide a site Traffic Plan with narrative and maps showing:
 - 1. Parking areas;
 - 2. Owner and Contractor destination points;
 - 3. Restricted areas;

4. Designated permanent and temporary routes for Contractor's and OWNER's operations;
5. Drawings of proposed signage text, color, size, and locations;
6. Anticipated schedules for temporary routing and durations;
- J. Submit the initial draft of the Traffic Plan as Record Data one week before meet with Construction Manager and OPT to discuss plan details. Revise Traffic Plan after the meeting and submit as Record Data.
- K. Discuss any anticipated changes to the Traffic Plan at monthly coordination meetings and revise the Traffic Plan as necessary.
- L. Submit a Notification by Contractor for OWNER's approval of a street closing at least 2 weeks before the time the road is to be closed. The request must state:
 1. The reason for closing the street.
 2. Dates and duration of period street will remain closed.
 3. Potential impacts on plant operations and maintenance activities.
 4. Procedures to be taken to maintain the flow of traffic, including maps of proposed alternate routes.
 5. Impacts on access by emergency vehicles and steps taken to maintain access.
 6. References to the Traffic Plan as appropriate.
- M. Provide route maps suitable for directing traffic to specific destination points. Update maps as necessary to incorporate changes made to the Traffic Plan.

1.16 BLASTING

- A. Blasting is not allowed for any purpose.

1.17 ARCHAEOLOGICAL REQUIREMENTS

- A. Cease operations immediately and contact the Owner for instructions if historical or archaeological artifacts are found during construction.
- B. Conduct all construction activities to avoid adverse impact of the sites where significant historical or archaeological artifacts are found or identified as an area where other artifacts could be found.
 1. Obtain details for working in these areas from regulatory agencies.
 2. Maintain confidentiality regarding the site(s) of artifacts.
 3. Adhere to the requirements of applicable local, state, and federal Laws and Regulations.
 4. Notify the Construction Manager and any local, state, or federal agency as required by applicable Laws and Regulations.
- C. Do not disturb archaeological sites.

1. Obtain the services of a qualified archaeological specialist to instruct construction personnel on how to identify and protect archaeological finds on an emergency basis.
2. Coordinate activities to permit archaeological work to take place within the area.
 - a. Attempt to archaeologically clear areas needed for construction as soon as possible.
 - b. Provide a determination of priority for such areas.
- D. Assume responsibility for any unauthorized destruction that might result to such sites by construction personnel, and pay all penalties assessed by state or federal agencies for non-compliance with these requirements.
- E. Contract Times will be modified to compensate for delays caused by such archaeological finds. No additional compensation will be paid for delays.

1.18 ENDANGERED SPECIES RESOURCES

- A. Do not perform any activity that is likely to destroy or adversely modify the habitat or jeopardize the continued existence of a threatened or endangered species as listed or proposed for listing under the Federal Endangered Species Act (ESA) or applicable state Laws and Regulations.
- B. Cease Work immediately in the area of the encounter and notify the Construction Manager if a threatened or endangered species is encountered during construction. Construction Manager will implement actions in accordance with the ESA and applicable state statutes. Resume construction in the area of the encounter when authorized to do so by the Construction Manager.

1.19 PRELIMINARY OCCUPANCY

- A. Owner may deliver, install, and connect equipment, furnishings, or other apparatus in buildings or other structures. These actions do not indicate acceptance of any part of the building or structure and does not affect the start of warranties or correction periods.
- B. Protect the Owner's property after installation is complete.
- C. Owner may use any product for testing or to determine that the product meets the requirements of the Contract Documents. This use does not constitute acceptance by OPT. These actions do not indicate acceptance of any part of the product and does not affect the start of warranties or correction periods.

1.20 OCCUPANCY

- A. Owner has the right to occupy or operate any portion of the Project that is ready for use after notifying the Contractor of its intent to do so.
- B. Testing of equipment and appurtenances including specified test periods, training, and startup does not constitute acceptance for operation.
- C. Owner may accept the facility for continued use after startup and testing at the option of the Owner. If acceptance is delayed at the option of the Owner, shut down facilities per approved operation and maintenance procedures.

- D. The execution of bonds is understood to indicate the consent of the surety to these provisions for occupancy of the structures and use of equipment.
- E. Provide an endorsement from the insurance carrier permitting occupancy of the structures and use of equipment during the remaining period of construction.
- F. Conduct operations to ensure the least inconvenience to the Owner and general public.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_31_13 PROJECT COORDINATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Administer contract requirements to construct the Project. Provide documentation per the requirements of this Section. Provide information as requested by the OPT.

1.02 DOCUMENTATION

- A. Provide documents in accordance with Section 01_33_00 Document Management.

1.03 COMMUNICATION DURING THE PROJECT

- A. Construction Manager is to be the first point of contact for all parties on matters concerning this Project.
- B. Construction Manager will coordinate correspondence concerning:
 - 1. Contract administration;
 - 2. Clarification and interpretation of the Contract Documents;
 - 3. Contract modifications;
 - 4. Observation of Work and testing; and
 - 5. Claims.
- C. Construction Manager will normally communicate only with the Contractor. Any required communication with Subcontractors or Suppliers will only be with the direct involvement of the Contractor.
- D. Direct written communications to the Construction Manager at the address indicated at the pre-construction conference. Include the following with communications as a minimum:
 - 1. Name of the Owner;
 - 2. Project name;
 - 3. Contract title;
 - 4. Project number;
 - 5. Date; and
 - 6. A reference statement.
- E. Submit communications on the forms referenced in this Section or in Section 01_33_00 Document Management.

1.04 PROJECT MEETINGS

- A. Pre-Construction Conference:
 - 1. Attend a pre-construction conference;
 - 2. The location of the conference will be determined by the Construction Manager;

3. The time of the conference will be determined by the Construction Manager, but will be after the Notice of Award is issued and not later than 15 days after the Notice to Proceed is issued;
 4. The OPT, Contractor's project manager and superintendent, representatives of utility companies, and representatives from major Subcontractors and Suppliers may attend the conference; and
 5. Provide and be prepared to discuss:
 - a. Preliminary construction schedule per Section 01_33_05 Construction Schedules;
 - b. Preliminary Schedule of Documents per Section 01_33_00 Document Management;
 - c. Schedule of Values and anticipated schedule of payments per Section 01_29_00 Application for Payment Procedures;
 - d. List of Subcontractors and Suppliers;
 - e. Contractor's organizational chart as it relates to this Project; and
 - f. Letter indicating the agents of authority for the Contractor and the limit of that authority with respect to the execution of legal documents, contract modifications, and payment requests.
- B. Progress Meetings:
1. Attend meetings with the Construction Manager, Design Professional, and Owner.
 - a. Meet monthly or as requested by the Construction Manager to discuss the Project.
 - b. Meet at the Site or other location as designated by the Construction Manager.
 - c. Contractor's superintendent and other key personnel are to attend the meeting. Other individuals may be requested to attend to discuss specific matters.
 - d. Notify the Construction Manager of any specific items to be discussed a minimum of 1 week prior to the meeting.
 2. Provide information as requested by the Construction Manager, Design Professional or Owner concerning this Project. Prepare to discuss:
 - a. Status of overall project schedule;
 - b. Contractor's detailed schedule for the next month;
 - c. Anticipated delivery dates for equipment;
 - d. Coordination with the Owner;
 - e. Status of documents;
 - f. Information or clarification of the Contract Documents;
 - g. Claims and proposed modifications to the Contract;
 - h. Field observations, problems, or conflicts; and
 - i. Maintenance of quality standards.

3. Construction Manager will prepare a record of meeting proceedings. Review the record of the meeting and notify the Construction Manager of any discrepancies within 10 days of the date the record of the meeting is provided. The record will not be corrected after the 10 days have expired. Corrections will be reflected in the record of the following meeting.
- C. Pre-Documentation and Pre-Installation Meetings:
1. Conduct pre documentation and pre installation meetings as required in the individual technical Specifications or as determined necessary by the Construction Manager (for example, instrumentation, roofing, concrete mix design, etc.).
 2. Set the time and location of the meetings when ready to proceed with the associated Work. Submit a Notification by Contractor in accordance with Paragraph 1.07 for the meeting 2 weeks before the meeting. OPT must approve of the proposed time and location.
 3. Attend the meeting and require the participation of appropriate Subcontractors and Suppliers in the meeting.
 4. Construction Manager will prepare a record of meeting proceedings. Review the record of the meeting and notify the Construction Manager of any discrepancies within 10 days of the date the record of the meeting is provided. The record will not be corrected after the 10 days have expired. Corrections will be reflected in the record of the following meeting.
- D. Weekly Coordination Meetings: Meet on a weekly basis with the Construction Manager or designated on-site representative of the OPT to discuss Work planned for the following week, review coordination issues, testing required, or other issues. Records of these meetings are not required.

1.05 REQUESTS FOR INFORMATION

- A. Submit a Request for Information to the Construction Manager to obtain additional information or clarification of the Contract Documents.
1. Submit a separate Request for Information for each item on the form provided by the Construction Manager.
 2. Attach adequate information to permit a response without further clarification. Construction Manager will return requests that do not have adequate information to the Contractor for additional information. Contractor is responsible for all delays resulting from multiple reviews due to inadequate information.
 3. A response will be made when adequate information is provided. The response will be made on the Request for Information form provided by the Construction Manager.
- B. Response to a Request for Information is given to provide additional information, interpretation, or clarification of the requirements of the Contract Documents, and does not modify the Contract Documents.
1. Submit a Change Proposal per Section 01_26_00 Change Management if a contract modification is suggested or required.

- C. Use the Decision Register to document decisions made at meetings and actions to be taken in accordance with Paragraph 1.06.
- D. Use the Action Item Register to document assignments for actions to be taken in accordance with Paragraph 1.06.

1.06 DECISION AND ACTION ITEM REGISTER

- A. Construction Manager will maintain a Decision Register to document key decisions made during meetings, telephone conversations, or visits to the Site using the format provided by the Construction Manager:
 - 1. Review the Decision Register prior to each regular meeting.
 - 2. Report any discrepancies to the Construction Manager for correction or discussion at the next monthly meeting.
- B. Construction Manager will maintain an Action Item Register in conjunction with the Decision Register to track assignments made during meetings, telephone conversations or visits to the Site using the format provided by the Construction Manager:
 - 1. Review the Action Item Register prior to each regular meeting.
 - 2. Report actions taken after the previous progress meeting on items in the register assigned to the Contractor or through the Contractor to a Subcontractor or Supplier to the Construction Manager. Report on status of progress 1 week prior to each progress meeting established in Paragraph 1.04 to allow Construction Manager to update the register prior to the Progress Meetings.
 - 3. Be prepared to discuss the status at each meeting.
- C. Decisions or action items in the register that require a change in the Contract Documents will have the preparation of a Modification as an action items if appropriate. The Contract Documents can only be changed by a Modification.

1.07 NOTIFICATION BY CONTRACTOR

- A. Notify the Construction Manager of:
 - 1. Need for testing;
 - 2. Intent to work outside regular working hours;
 - 3. Request to shut down facilities or utilities;
 - 4. Proposed utility connections;
 - 5. Required observation by Construction Manager, Engineer, or inspection agencies prior to covering Work; and
 - 6. Training.
- B. Provide notification a minimum of 2 weeks in advance in order to allow OPT time to respond appropriately to the notification.
- C. Use the Notification by Contractor form provided by the Construction Manager.

1.08 REQUESTS FOR MODIFICATIONS

- A. Submit requests for Modifications per Section 01_26_00 Change Management.

1.09 PLAN OF ACTION

- A. Submit a written Plan of Action for approval for shutting down essential services. These include:
 - 1. Electrical power;
 - 2. Control power;
 - 3. Process piping;
 - 4. Process equipment;
 - 5. Communications equipment; and
 - 6. Other designated functions.
- B. Describe the following in the Plan of Action:
 - 1. Scheduled dates for construction;
 - 2. Work to be performed;
 - 3. Utilities, piping, or services affected;
 - 4. Length of time the service or utility will be disturbed;
 - 5. Procedures to be used to carry out the Work;
 - 6. Plan of Action to handle emergencies;
 - 7. List of manpower, equipment, and ancillary supplies;
 - 8. Backups for key pieces of equipment and key personnel;
 - 9. Contingency plan that will be used if the original schedule cannot be met; and
- C. Submit plan 1 month prior to beginning the Work.

1.10 RECORD DATA

- A. Submit information required by the Contract Documents that is not related to a product as Record Data using the form provided by the Construction Manager.

1.11 RECORD DOCUMENTS

- A. Maintain one complete set of printed Record Documents at the Site including:
 - 1. Drawings;
 - 2. Specifications;
 - 3. Addenda;
 - 4. Modifications;
 - 5. Product Data and approved Shop Drawings;

6. Construction photographs;
 7. Test Reports;
 8. Clarifications and other information provided in Request for Information responses; and
 9. Reference standards.
- B. Store printed Record Documents and Samples in the Contractor's field office.
1. Record Documents are to remain separate from documents used for construction.
 2. Provide files and racks for the storage of Record Documents.
 3. Provide a secure storage space for the storage of Samples.
 4. Maintain Record Documents in clean, dry, legible conditions, and in good order.
 5. Make Record Documents and Samples available at all times for inspection by the OPT.
- C. Maintain an electronic record of Specifications and Addenda to identify products provided in PDF format.
1. Reference the Product Data number, Shop Drawing number, and O&M manual number for each product and item of equipment furnished or installed.
 2. Reference Modifications by type and number for all changes.
- D. Maintain an electronic record of Drawings in PDF format.
1. Reference the Product Data number, Shop Drawing number, and O&M manual number for each product and item of equipment furnished or installed.
 2. Reference Modifications by type and number for all changes.
 3. Record information as construction is being performed. Do not conceal any Work until the required information is recorded.
 4. Mark drawings to record actual construction.
 - a. Depths of various elements of the foundation in relation to finished first floor datum or the top of walls.
 - b. Horizontal and vertical locations of underground utilities and appurtenances constructed, and existing utilities encountered during construction.
 - c. Location of utilities and appurtenances concealed in the Work. Refer measurements to permanent structures on the surface. Include the following equipment:
 - 1) Piping;
 - 2) Ductwork;
 - 3) Equipment and control devices requiring periodic maintenance or repair;
 - 4) Valves, unions, traps, and tanks;
 - 5) Services entrance;
 - 6) Feeders; and

- 7) Outlets.
 - d. Changes of dimension and detail.
 - e. Changes by Modifications.
 - f. Information in Requests for Information or included in the Decision Register.
 - g. Details not on the original Drawings. Include field verified dimensions and clarifications, interpretations, and additional information issued in response to Requests for Information.
- 5. Mark Drawings with the following colors:
 - a. Highlight references to other documents, including Modifications in blue.
 - b. Highlight mark ups for new or revised Work (lines added) in yellow.
 - c. Highlight items deleted or not installed (lines to be removed) in red.
 - d. Highlight items constructed per the Contract Documents in green.
 - 6. Submit Record Documents to Construction Manager for review and acceptance 30 days prior to Final Completion of the Project.
- E. Applications for Payment will not be recommended for payment if Record Documents are found to be incomplete or not in order. Final payment will not be recommended without complete Record Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_33_00 DOCUMENT MANAGEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Submit documentation as required by the Contract Documents and as requested by the Construction Manager.
- B. Use the e-Builder Project Management Information System (PMIS) provided by the City of Arlington. Software has the following system requirements:
 - 1. Operating Systems: Windows 7 or later and OS X v10.8 or later.
 - 2. Supported Internet Browsers: Internet Explorer 11.0 or later, Google Chrome 70.0 or later, Firefox 63.0 or later, Safari 11.0 or later, and Microsoft Edge 17.0 or later.
 - 3. Screen Resolution: The recommended screen resolution is 1280 x 1024 or higher. The minimum screen resolution required to support all features is 1024 x 768.
- C. Contractor will be provided access to e-Builder for up to 3 persons. Additional seats may be available at an additional cost which will be applied to the contract as a set off.

1.02 QUALITY ASSURANCE

- A. Submit legible, accurate, complete documents presented in a clear, easily understood manner. Documents not meeting these criteria will be returned without review as "Not Approved."

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Review documents prior to submission. Make certifications as required by the Contract Documents and as indicated on Construction Manager provided forms.
- B. Provide a Schedule of Documents to list the documents that are to be submitted, the dates on which documents are to be sent to the Construction Manager for review. Use the form provided by the Construction Manager for this list.
- C. Incorporate the dates for processing documents into the Progress Schedule required by Section 01_33_05 Construction Schedules.
 - 1. Provide documents in accordance with the schedule so construction of the Project is not delayed.
 - 2. Allow a reasonable time for the review of documents when preparing the Progress Schedule. Assume a 14-day review cycle for each document unless a longer period is indicated in the Contract Documents or agreed to by Construction Manager and Contractor.
 - 3. Schedule delivery of review documents to provide all information for interrelated Work at one time.
 - 4. Allow adequate time for processing documents so construction of the Project is not delayed.

1.04 FORMS AND WORKFLOWS

- A. Use the forms or workflow process provided by the Construction Manager for project documentation.

1.05 DOCUMENT PREPARATION AND DELIVERY PROCEDURES

- A. Deliver documents in electronic format as directed by the Construction Manager.
 - 1. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.
 - 2. Deliver all documents in Portable Document Format (PDF).
 - a. Create PDF document using Bluebeam Revu software.
 - b. Create PDF documents from native format files unless files are only available from scanned documents.
 - c. Rotate pages so that the top of each document appears at the top of the monitor screen when opened in PDF viewing software.
 - d. Provide PDF document with adequate resolution to allow documents to be printed in a format equivalent to the document original. Documents are to be scalable to allow printing on standard 8-1/2 x 11 or 11 x 17 paper.
 - e. Submit color PDF documents where color is required to interpret the document.
 - f. Create or convert documents to allow text to be selected for comments or searched using text search features. Run scanned documents through Optical Character Recognition (OCR) software if necessary.
 - g. Flatten markups in documents to prevent markups made by Contractor from being moved or deleted. Flatten documents to allow markup recovery.
 - h. Use Bluebeam Revu software to reduce file size using default settings except the option for "Drop Metadata." Uncheck the "Drop Metadata" box when reducing file size.
 - i. Add footers to each document with the name of the Project.
- B. Software Requirements:
 - 1. OPT and Contractor will each acquire the software and software licenses necessary to create and transmit Electronic Documents and to read and to use any Electronic Documents received from the other party (and if relevant from third parties), using the following software formats:

Document	Document Format
Email	.htm, .rtf, or .txt without formatting that impairs legibility of content on screen or in printed copies
Submittals	Bluebeam PDF
Applications for Payment	Bluebeam PDF and Microsoft® Excel
Progress Schedules	PDF and Schedule in Native Format

Document	Document Format
Layouts and drawings to be submitted to Owner for future use and modification.	Autodesk® AutoCAD .dwg format
Document submitted to OPT for future word processing use and modification.	Microsoft® Word
Spreadsheets and data submitted to OPT for future data processing use and modification.	Microsoft® Excel

2. Software will be the version currently published at the time Contract is signed unless a specific software version is listed in the Supplementary Conditions. Prior to using any updated version of the software required in this Section for sending Electronic Documents to the other party, the originating party will first notify and receive concurrence from the other party for use of the updated version or convert to comply with this Paragraph.

1.06 DOCUMENTATION

- A. Furnish documents as indicated in the individual Specification Sections. Submit documents per the procedures described in the Contract Documents.
- B. Submit documents per the Specification Sections shown in the following table:

Document Type	Specification Section
Application for Payment	01_29_00
Certified Test Report	01_33_02 for approval of product 01_40_00 to demonstrate compliance
Change Management	01_26_00
Equipment Installation Report	01_75_00
Graphic Documentation	01_33_06
Notification by Contractor	01_31_13
Operation & Maintenance Manuals	01_33_04
Product Data	01_33_03
Progress Schedules	01_33_05
Record Data	01_31_13
Request for Information	01_31_13
Schedule of Values	01_29_00
Shop Drawing	01_33_02
Substitutions	01_26_00
Suppliers and Subcontractors	01_31_13 01_33_03

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_33_02 SHOP DRAWINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Shop Drawings are required for those products that cannot adequately be described in the Contract Documents to allow fabrication, erection, or installation of the product without additional detailed information from the Supplier.
- B. Submit Shop Drawings as required by the Contract Documents and as reasonably requested by the Construction Manager to:
 - 1. Record the products incorporated into the Project;
 - 2. Provide detailed information for the products proposed for the Project regarding their fabrication, installation, commissioning, and testing; and
 - 3. Allow the Design Professional to advise the Owner if products proposed for the Project by the Contractor conform, in general, to the design concepts of the Contract Documents.
- C. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the review of Shop Drawings, Samples, or mockups.
- D. Submit a Change Proposal per Section 01_26_00 Change Management to request modifications to the Contract Documents, including those for approval of "or equal" products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures. Deviations from the Contract Documents can only be approved Change Order or Field Order.

1.02 QUALITY ASSURANCE

- A. Submit legible, accurate, and complete documents presented in a clear, easily understood manner. Shop Drawings not meeting these criteria will not be approved.
- B. Demonstrate that the proposed products are in full compliance with the design criteria and requirements of the Contract Documents or will be if deviations requested per Paragraph 1.11 are approved.
- C. Furnish and install products that fully comply with the information included in the Shop Drawings.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Furnish Shop Drawings for products as indicated in the individual Specification Sections.
- B. Include Shop Drawings in the Document Register required by Section 01_33_00 Document Management to indicate the Shop Drawings to be submitted, the dates on which Shop Drawings are to be sent to the Construction Manager for review, and proposed dates that the product will be incorporated into the Project.
- C. Incorporate the dates for processing Shop Drawings into the Progress Schedule required by Section 01_33_05 Construction Progress Schedule.

1. Submit Shop Drawings in accordance with the schedule so construction of the Project is not delayed.
 2. Submit Shop Drawings for interrelated Work at one time.
 3. Allow adequate time for ordering, fabricating, delivering, and installing products so construction of the Project is not delayed.
- D. Complete the following before submitting a Shop Drawing or Sample:
1. Prepare and review the Shop Drawing or Sample. Coordinate the Shop Drawing or Sample with other Shop Drawings and Samples, with the requirements of the Work, and the Contract Documents;
 2. Determine and verify specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to Shop Drawings and Samples;
 3. Determine and verify the suitability of materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 4. Determine and verify information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
- E. Determine and verify:
1. Field measurements, quantities, and dimensions are shown on the Shop Drawing and are accurate;
 2. Location of existing structures, utilities, and equipment related to the Shop Drawing have been shown and conflicts between the products, existing structures, utilities, and equipment have been identified;
 3. Conflicts that impact the installation of the products have been brought to the attention of the Construction Manager;
 4. Shop Drawing is complete for its intended purpose; and
 5. Conflicts between the Shop Drawing related to the various Subcontractors and Suppliers have been resolved.
- F. Review Shop Drawings prior to submitting to the Construction Manager. Certify that all Shop Drawings have been reviewed by the Contractor and are in strict conformance with the Contract Documents as modified by Addenda, Change Order, Field Order, or Contract Amendment when submitting Shop Drawings except for deviations specifically brought to the Construction Manager's attention on an attached Shop Drawing Deviation Request form in accordance with Paragraph 1.10.
- G. Fabrication or installation of any products prior to the approval of Shop Drawings is done at the Contractor's risk. Defective products may be rejected at the Owner's option.
- H. Payment will not be made for products for which Shop Drawings or Samples are required until these are approved by the Construction Manager and Design Professional.

1.04 DOCUMENTATION

- A. Provide adequate information in Shop Drawings and with Samples so the Design Professional can:
 - 1. Assist the Owner in selecting colors, textures, or other aesthetic features.
 - 2. Compare the proposed features of the product with the specified features and advise Owner that the product does, in general, conform to the Contract Documents.
 - 3. Compare the performance features of the proposed product with those specified and advise the Owner that the product does, in general, conform to the performance criteria specified in the Contract Documents.
 - 4. Review required certifications, guarantees, warranties, and service agreements for compliance with the Contract Documents.
- B. Include a complete description of the material or equipment to be furnished, including:
 - 1. Type, dimensions, size, arrangement, model number, and operational parameters of the components;
 - 2. Weights, gauges, materials of construction, external connections, anchors, and supports required;
 - 3. Performance characteristics, capacities, engineering data, motor curves, and other information necessary to allow a complete evaluation of mechanical components;
 - 4. All applicable standards;
 - 5. Fabrication and installation drawings, setting diagrams, manufacturing instructions, templates, patterns, and coordination drawings;
 - 6. Wiring and piping diagrams and related controls;
 - 7. Mix designs for concrete, asphalt, or other materials proportioned for the Project; and
 - 8. Complete and accurate field measurements for products which must fit existing conditions. Indicate on the document that the measurements represent actual dimensions obtained at the Site.
- C. Submit Shop Drawings that require coordination with other Shop Drawings for fabrication at the same time. Shop Drawings requiring coordination with other Shop Drawings will not be approved until a complete package is submitted, unless approved by the Construction Manager.
- D. Submit information for all of the components and related equipment required for a complete and operational system in one Submittal.
 - 1. Include electrical, mechanical, and other information required to indicate how the various components of the system function together as a system.
 - 2. Provide certifications, warranties, and written guarantees and service contracts with the document package for review when these are required.

1.05 SPECIAL CERTIFICATIONS AND REPORTS

- A. Provide all required special certifications, reports, and other documentation with the Shop Drawings as specified in the individual Specification Sections which may include:
 - 1. Certified Test Reports (CTR): A report prepared by an approved testing agency giving results of tests performed on products to indicate their compliance with the Specifications. This report is to demonstrate that the product, when installed, will meet the requirements of the Contract Documents and is part of the Shop Drawing. Field tests may be performed by the Owner to determine that in place materials or products meet the same quality as indicated in the CTR submitted as part of the Shop Drawing.
 - 2. Certification of Local Field Service (CLS): A certified letter stating that field service is available from a factory or supplier approved service organization located within a 300-mile radius of the Site. Include the names, addresses, and telephone numbers of approved service organizations with the certificate.
 - 3. Certification of Adequacy of Design (CAD): A certified letter from the manufacturer of the equipment stating that the equipment has been designed to be structurally stable and to withstand all imposed loads without deformation, failure, or adverse effects to the performance and operational requirements of the unit. The letter must state that mechanical and electrical components have been adequately sized to be fully operational for the conditions specified or normally encountered by the product's intended use.
 - 4. Certification of Applicator/Subcontractor (CSQ): A certified letter stating that the applicator or subcontractor proposed to perform a specified function is duly designated as factory authorized and trained for the application of the specified product.

1.06 WARRANTIES AND GUARANTEES

- A. Provide all required warranties, guarantees, and related documents with the Shop Drawing. The effective date of warranties and guarantees will be the date of Substantial Completion.
- B. Identify all extended warranties which are defined as any guarantee of performance for the product or system beyond the one-year correction period described in the General Conditions. Issue the warranty certificate in the name of the Owner. Provide a warranty bond for extended warranties if required by the individual Specification Sections.
- C. Include an additional copy of equipment warranties in operation and maintenance manuals.
- D. Provide a copy of all warranties in a separate document in accordance with Section 01_70_00 Execution and Closeout Requirements.

1.07 EXTENDED SERVICE AGREEMENTS

- A. Provide Extended Service Agreements and related documents with the Product Data. An Extended Service Agreement is a contract between the Owner and an approved Subcontractor or Supplier to provide service and or maintenance beyond that required to

fulfill requirements for warranty repairs, or to perform routine maintenance for a definite period beyond the one-year correction period specified in the General Conditions.

- B. An Extended Service Agreement does not relieve the Contractor from obligations under the one-year correction period or warranty provisions specified in the General Conditions
- C. An Extended Service Agreement does not relieve the Contractor from obligations under the maintenance bond, if a maintenance bond is required by the Contract.
- D. Requirements for the Extended Service Agreement are described in the Specification Sections for each piece of equipment or system requiring an Extended Service Agreement.
- E. Enter into a contract with the service provider and assign the service contract to the Owner on the date Substantial Completion. Once assigned to the Owner, Contract requirements for the Extended Service Agreement will be complete and will not extend the Contract between the Owner and Contractor.
- F. Owner may require that a performance bond be provided for the Extended Service Agreement. Provide a separate bond meeting the same requirements as those for the Contractor's performance bond if required. The bond will be in the amount of the Extended Service Agreement.
- G. Include an additional copy of Extended Service Agreements in operation and maintenance manuals.
- H. Provide a copy of Extended Service Agreements in a separate document in accordance with Section 01_70_00 Execution and Closeout Requirements.

1.08 SHOP DRAWING SUBMITTAL PROCEDURES

- A. Submit Shop Drawings to the Construction Manager. Send all documents in digital format for processing.
 - 1. Provide all information requested. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.
 - 2. Submit all documents in Portable Document Format (PDF) as required by Section 01_33_00 Document Management. Provide color PDF documents where color is required to interpret the Shop Drawing. Provide Samples and color charts per Paragraph 1.10.
 - 3. Submit each specific product, class of material, or equipment system separately so these can be tracked and processed independently. Do not submit Shop Drawings for more than one independent system in the same Submittal.
 - 4. Submit items specified in different Specification Sections separately unless they are part of an integrated system.
 - 5. Define abbreviations and symbols used in Shop Drawings.
 - a. Use terms and symbols in Shop Drawings consistent with the Contract Drawings.
 - b. Provide a list of abbreviations and their meaning as used in the Shop Drawings.
 - c. Provide a legend for symbols used on Shop Drawings.

6. Mark Shop Drawings to reference:
 - a. Related Specification Sections;
 - b. Drawing number and detail designation;
 - c. Equipment designation or name;
 - d. Schedule references;
 - e. System into which the product is incorporated; and
 - f. Location where the product is incorporated into the Project.
- B. Use the following conventions to markup Shop Drawings for review:
 1. Make comments and corrections in the color blue. Add explanatory comments to the markup.
 2. Highlight items in black (redact) that are not being furnished when the Supplier's standard drawings or information sheets are provided so that only the products to be provided are in their original color.
 3. Make comments in yellow where selections or decisions by the Design Professional are required, but such selections do not constitute a deviation from the Contract Documents. Add explanatory comments to the markup to indicate the action requested of the Design Professional.
 4. Make comments in orange that are deviation requests. Include the deviation request number on the Shop Drawing that corresponds to the deviation request on the Shop Drawing Deviation Request form. Include explanatory comments in the Shop Drawing Deviation Request form.
 5. Mark dimensions with the prefix "FD" to indicate field verified dimensions on the Shop Drawings.
- C. Designate a document as requiring priority treatment to place the review of the Shop Drawing ahead of other Shop Drawings previously delivered. Shop Drawings are typically reviewed in the order received, unless Contractor requests that a different priority be assigned. Priority Shop Drawings will be reviewed before other Shop Drawings already received but not yet reviewed. Use of this priority designation for Shop Drawings may delay the review of Shop Drawings previously submitted. Contractor is responsible for delays resulting from the use of the priority designation status on Shop Drawings.
- D. Complete the certification required by Paragraph 1.03.F.

1.09 SAMPLE AND MOCKUP SUBMITTAL PROCEDURES

- A. Submit color charts and Samples for every product requiring color, texture, or finish selection.
 1. Submit color charts and Samples only after Shop Drawings for the products have been approved.
 2. Deliver all color charts and Samples at one time.
 3. Provide Samples of adequate size to clearly illustrate the functional characteristics of the product, with integrally related parts and attachment devices.

4. Indicate the full range of color, texture, and patterns.
 5. Deliver color charts and Samples to the field office and store for the duration of the Project.
 6. Notify the Construction Manager that color charts and Samples have been delivered for approval using the Notification by Contractor form.
 7. Submit color charts and Samples not less than 30 days prior to when these products are to be ordered or released for fabrication to comply with the Project schedule.
 8. Remove Samples that have not been approved. Submit new Samples following the same process as for the initial Sample until Samples are approved.
 9. Dispose of Samples when related Work has been completed and approved and disposal is approved by the Construction Manager. At Owner's option, Samples will become the property of the Owner.
- B. Construct mockups for comparison with the Work being performed.
1. Construct mockups from the actual products to be used in construction per the detailed specifications.
 2. Construct mockups of the size and in the area indicated in the Contract Documents.
 3. Construct mockups complete with texture and finish to represent the finished product.
 4. Notify the Construction Manager that mockups have been constructed and are ready for approval using the Notification by Contractor form. Allow 2 weeks for Construction Manager to approve of the mockup before beginning the Work represented by the mockup.
 5. Remove mockups that have not been approved. Construct new mockups following the same process as for the initial mockup until mockup is approved.
 6. Protect mockups until Work has been completed and accepted by the Construction Manager.
 7. Dispose of mockups when related Work has been completed and disposal is approved by the Construction Manager.

1.10 REQUESTS FOR DEVIATION

- A. Submit a Change Proposal per Section 01_26_00 Change Management to request modifications to the Contract Documents, including those for approval of or equal products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures.
- B. Provide a Shop Drawing with the Change Proposal that clearly identifies deviations for any product or component of the product that does not fully comply with the Contract Documents using the Shop Drawing Deviation Request form provided by the Construction Manager. Mark deviations on the Shop Drawing per Paragraph 1.08.B
- C. Include a description of why the deviation is required and the impact on Contract Price or Contract Times. Include the amount of any cost savings to the Owner for deviations that result in a reduction in cost.

- D. Identify each deviation request as a separate item. Include all requested deviations that must be approved as a group together and identify them as a single item.
- E. Construction Manager will issue a Field Order or Change Order to approve acceptable deviations. Approval of a requested Shop Drawing deviation by the Design Professional on the Shop Drawings Deviation Request form indicates approval of the requested deviation only on its technical merits as generally conforming to the Contract Documents. Deviations from the Contract Documents can only be approved by a Modification issued by the Construction Manager.

1.11 CONSTRUCTION MANAGER AND DESIGN PROFESSIONAL RESPONSIBILITIES

- A. Shop Drawings will be received by the Construction Manager. Construction Manager will log the documents and forward to the Design Professional for review per this Section for general conformance with the Contract Documents.
 - 1. Design Professional's review and approval will be only to determine if the products described in the Shop Drawing or Sample will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
 - 2. Design Professional's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.
 - 3. Design Professional's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
- B. Comments will be made on items called to the attention of the Design Professional for review and comment. Any marks made by the Design Professional do not constitute a blanket review of the document or relieve the Contractor from responsibility for errors or deviations from the Contract requirements.
 - 1. Design Professional will respond to Contractor's markups by either making markups directly in the Shop Drawing file using the color red or by attaching a Document Review Comments form with review comments keyed to the Drawings or Shop Drawing Deviation Request.
 - 2. Shop Drawings that are reviewed will be returned with one or more of the following status designations:
 - a. Approved: Shop Drawing is found to be acceptable as submitted.
 - b. Approved as Noted: Shop Drawing is approved so long as corrections or notations made by Design Professional are incorporated into the Shop Drawing.
 - c. Not Approved: Shop Drawing or products described are not acceptable.
 - d. Cancelled: This action indicates that for some reason, the Shop Drawing is to be removed from consideration and all efforts regarding the processing of that document are to cease.

3. Shop Drawings will also be designated for one of the following actions:
 - a. Documents Filed: Shop Drawing is acceptable without further action and has been filed as a record document.
 - b. Shop Drawing Not Required: A Shop Drawing was not required by the Contract Documents. Resubmit the document per Section 01_33_03 Product Data.
 - c. Cancelled: This action indicates that for some reason, the Shop Drawing is to be removed from consideration and all efforts regarding the processing of that document are to cease.
 - d. Revise and Resubmit: Shop Drawing has deviations from the Contract Documents, significant errors, or is inadequate and must be revised and resubmitted for subsequent review.

Actions in paragraphs "a" through "c" will close out the Shop Drawing review process and no further action is required as a Shop Drawing. Action d requires follow up action to close out the review process.

4. Drawings with a significant or substantial number of markings by the Contractor may be marked "Approved as Noted." These drawings are to be revised to provide a clean record of the document. Proceed with ordering products as the documents are revised.
 5. Dimensions or other data that do not appear to conform to the Contract Documents will be marked as "At Variance With" (AVW) the Contract Documents or other information provided. The Contractor is to make revisions as appropriate to comply with the Contract Documents.
- C. Bring deviations to the Shop Drawings to the attention of the Design Professional for approval by using the Shop Drawing Deviation Request form. Use a single line for each requested deviation so the Status and Action for each deviation can be determined for that requested deviation. If approval or rejection of a requested deviation will impact other requested deviation, then all related deviations should be included in that requested deviation line so the status and action can be determined on the requested deviation as a whole.
- D. Requested deviations will be reviewed as a possible Modification to the Contract Documents.
1. A requested deviation will be marked as "Not Approved" if the requested deviation is unacceptable. Contractor is to revise and resubmit the Shop Drawing with corrections for approval.
 2. A Field Order will be issued by the Construction Manager for deviations approved by the Design Professional if the requested deviation is acceptable and if the requested deviation will not result in a change in Contract Price or Contract Times. Requested deviations from the Contract Documents may only be approved by Field Order.
 3. A requested deviation will not be approved if the requested deviation is acceptable but the requested deviation will or should result in a change in Contract Price or Contract Times. Submit any requested deviation that requires a change in Contract

Price or Contract Times as a Change Proposal for approval prior to resubmitting the Shop Drawing.

- E. Contractor is to resubmit a complete Shop Drawing incorporating revisions until it is acceptable and marked "Approved" or "Approved as Noted" and is assigned an action per Paragraph 1.12.B.3 that indicates that the Shop Drawing process is closed.
- F. Information that is submitted as a Shop Drawing that should be submitted as Product Data or other type of document, or is not required may be returned without review, or may be deleted. No further action is required and the Shop Drawing process for this document will be closed.

1.12 RESUBMISSION REQUIREMENTS

- A. Make all corrections or changes required by the Design Professional in the document and resubmit to the Construction Manager until approved.
- B. Resubmit a complete Shop Drawing for each resubmittal. The last approved Shop Drawing must not rely on previous submissions. The final Shop Drawing is to provide a complete record for the Owner's records.
- C. Revise initial drawings or data and resubmit as specified for the reviewed document.
 - 1. Highlight or cloud in green those revisions which have been made in response to the previous reviews by the Design Professional. This will include changes previously highlighted or clouded in yellow to direct attention to Design Professional to items requiring selections, decisions by the Design Professional or highlighted or clouded in orange for a requested deviation from the Contract Documents, or comments in red made by the Construction Manager.
 - 2. Highlight and cloud new items in yellow where selections or decisions by the Design Professional are required, but such selections do not constitute a deviation from the Contract Documents. Add explanatory comments to the markup to indicate the action to be taken by the Design Professional.
 - 3. Highlight and cloud new items in orange that are deviation requests. Include the deviation request number on the Shop Drawing that corresponds to the deviation request on the Shop Drawing Deviation Request form. Numbering for these new items is to start with the next number following the last Shop Drawing deviation requested. Include explanatory comments in the Shop Drawing Deviation Request form.
- D. Pay for excessive review of Shop Drawings.
 - 1. Excessive review of Shop Drawings is defined as any review required after the original review has been made and the first resubmittal has been checked to see that corrections have been made.
 - 2. Review of Shop Drawings or Samples will be an additional service requiring payment by the Contractor if the Contractor submits a substitution for a product for which a Shop Drawing or Sample has previously been approved, unless the need for such change is beyond the control of Contractor.
 - 3. Cost for additional review time will be billed to the Owner by the Design Professional for the actual hours required for the review of Shop Drawings by Design Professional

and in accordance with the rates listed in Section 00_73_00 Supplementary Conditions.

4. A set-off will be included in each Application for Payment to pay the cost for the additional review. The set-off will be based on invoices submitted to the Owner for these services.
5. Need for more than one resubmission or any other delay in obtaining Design Professional's approval of Shop Drawings will not entitle the Contractor to an adjustment in Contract Price or an extension of Contract Times.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_33_03 PRODUCT DATA

PART 1 - GENERAL

1.01 SUMMARY

- A. Submit Product Data as required by the Contract Documents and as reasonably requested by the Construction Manager. Provide Product Data for all products unless a Shop Drawing is required for the same item.
- B. Submit Product Data to provide documents that allow the Owner to:
 - 1. Record the products incorporated into the Project;
 - 2. Record detailed information about products regarding their fabrication, installation, commissioning, and testing; and
 - 3. Provide replacement or repair of products at some future date.
- C. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the receipt or cursory review of Product Data.
- D. Submit a Change Proposal per Section 01_26_00 Change Management to request modifications to the Contract Documents, including those for approval of "or equal" products when specifically allowed by the Contract Documents or as a substitution for specified products or procedures. Deviations from the Contract Documents can only be made by an approved Change Order or Field Order.

1.02 QUALITY ASSURANCE

- A. Submit legible, accurate, and complete documents presented in a clear, easily understood manner. Product Data not meeting these criteria will not be accepted and must be resubmitted.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Furnish Product Data for products as indicated in the individual Specification Sections.
- B. Include Product Data in the Document Register required by Section 01_33_00 Document Management to indicate the Product Data to be submitted, the dates on which documents are to be sent to the Construction Manager for review, and proposed dates that the product will be incorporated into the Project.
- C. Complete the following before submitting Product Data:
 - 1. Prepare Product Data and coordinate with Shop Drawings, Samples, Product Data for related products, and with the requirements of the Contract Documents;
 - 2. Determine and verify specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information;
 - 3. Determine and verify the suitability of materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. Determine and verify information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
- D. Determine and verify:
1. Field measurements, quantities, and dimensions are shown on the Product Data and are accurate;
 2. Location of existing structures, utilities, and equipment related to the Product Data have been shown and conflicts between the products, existing structures, utilities, and equipment have been brought to the attention of the Construction Manager;
 3. Conflicts that impact the installation of the products have been brought to the attention of the Construction Manager;
 4. Product Data is complete for its intended purpose; and
 5. Conflicts between the Product Data related to the various Subcontractors and Suppliers have been resolved.
- E. Review Product Data prior to submitting to the Construction Manager. Certify that all Product Data has been reviewed by the Contractor and is in strict conformance with the Contract Documents as modified by Addenda, Change Order, Field Order, or Contract Amendment when submitting Product Data.

1.04 DOCUMENTATION

- A. Include a complete description of the material or equipment to be furnished, including:
1. Type, dimensions, size, arrangement, model number, and operational parameters of the components;
 2. Weights, gauges, materials of construction, external connections, anchors, and supports required;
 3. Performance characteristics, capacities, engineering data, motor curves, and other information necessary to allow a complete evaluation of mechanical components;
 4. All applicable standards;
 5. Fabrication and installation drawings, setting diagrams, manufacturing instructions, templates, patterns, and coordination drawings;
 6. Wiring and piping diagrams and related controls;
 7. Mix designs for concrete, asphalt, or other materials proportioned for the Project; and
 8. Complete and accurate field measurements for products which must fit existing conditions. Indicate on the document that the measurements represent actual dimensions obtained at the Site.
- B. Submit information for all components and related equipment required for a complete and operational system in one submittal.
1. Include electrical, mechanical, and other information required to indicate how the various components of the system function together as a system.

2. Provide certifications, warranties, and written guarantees and service contracts with the document package for review when these are required.

1.05 SPECIAL CERTIFICATIONS AND REPORTS

- A. Provide all required certifications with the Product Data as specified in the individual Specification Sections:
 1. Certified Test Reports (CTR): A report prepared by an approved testing agency giving results of tests performed on products to indicate their compliance with the Specifications. This report is to demonstrate that the product when installed will meet the requirements of the Contract Documents and is part of the Product Data. Field tests may be performed by the Owner to determine that in place materials or products meet the same quality as indicated in the CTR submitted as part of the Product Data.
 2. Certification of Local Field Service (CLS): A certified letter stating that field service is available from a factory or supplier approved service organization located within a 300-mile radius of the Site. Include the names, addresses, and telephone numbers of approved service organizations with the certificate.
 3. Certification of Adequacy of Design (CAD): A certified letter from the manufacturer of the equipment stating that the equipment has been designed to be structurally stable and to withstand all imposed loads without deformation, failure, or adverse effects to the performance and operational requirements of the unit. The letter must state that mechanical and electrical components have been adequately sized to be fully operational for the conditions specified or normally encountered by the product's intended use.
 4. Certification of Applicator/Subcontractor (CSQ): A certified letter stating that the applicator or subcontractor proposed to perform a specified function is duly designated as factory authorized and trained for the application of the specified product.

1.06 WARRANTIES AND GUARANTEES

- A. Provide all required warranties, guarantees, and related documents with the Product Data. The effective date of warranties and guarantees will be the date of Substantial Completion.
- B. Identify all Extended Warranties which are defined as any guarantee of performance for the product or system beyond the one-year correction period described in the General Conditions. Issue the warranty certificate in the name of the Owner. Provide a warranty bond for extended warranties if required by Specification Sections.
- C. Include an additional copy of equipment warranties in operation and maintenance manuals.
- D. Provide a copy of all warranties in a separate document in accordance with Section 01_70_00 Execution and Closeout Requirements.

1.07 EXTENDED SERVICE AGREEMENTS

- A. Provide Extended Service Agreements and related documents with the Product Data. An Extended Service Agreement is a contract between the Owner and an approved

Subcontractor or Supplier to provide service and or maintenance beyond that required to fulfill requirements for warranty repairs, or to perform routine maintenance for a definite period beyond the one-year correction period specified in the General Conditions.

- B. An Extended Service Agreement does not relieve the Contractor from obligations under the one-year correction period or Warranty provisions specified in the General Conditions.
- C. An Extended Service Agreement does not relieve the Contractor from obligations under the maintenance bond, if a maintenance bond is required by the Contract.
- D. Requirements for the Extended Service Agreement are described in the Specification Sections for each piece of equipment or system requiring an Extended Service Agreement.
- E. Enter into a contract with the service provider and assign the service contract to the Owner on the date of Substantial Completion. Once assigned to the Owner, Contract requirements for the Extended Service Agreement will be complete and will not extend the Contract between the Owner and Contractor.
- F. Owner may require that a performance bond be provided for the Extended Service Agreement. Provide a separate bond meeting the same requirements as those for the Contractor's performance bond if required. The bond will be in the amount of the Extended Service Agreement.
- G. Include an additional copy of Extended Service Agreements in operation and maintenance manuals.
- H. Provide a copy of Extended Service Agreements in a separate document in accordance with Section 01_70_00 Execution and Closeout Requirements.

1.08 PRODUCT DATA SUBMITTAL PROCEDURES

- A. Submit Product Data to the Construction Manager. Send all documents in digital format for processing.
 - 1. Provide all information requested. Do not leave any blanks incomplete. If information is not applicable, enter NA in the space provided.
 - 2. Submit all documents in Portable Document Format (PDF) as required by Section 01_33_00 Document Management. Provide color PDF documents where color is required to interpret the Product Data.
 - 3. Submit each specific product, class of material, or equipment system separately so these can be tracked and processed independently. Do not submit Product Data for more than one system in the same Submittal.
 - 4. Submit items specified in different Specification Sections separately unless they are part of an integrated system.
 - 5. Define abbreviations and symbols used in Product Data.
 - a. Use terms and symbols in Product Data consistent with the Contract Drawings.
 - b. Provide a list of abbreviations and their meaning as used in the Product Data.
 - c. Provide a legend for symbols used on Product Data.

6. Mark Product Data to reference:
 - a. Related Specification Sections;
 - b. Drawing number and detail designation;
 - c. Equipment designation or name;
 - d. Schedule references;
 - e. System into which the product is incorporated; and
 - f. Location where the product is incorporated into the Project.

B. Complete the certification required by Paragraph 1.03.F.

1.09 CONSTRUCTION MANAGER AND DESIGN PROFESSIONAL RESPONSIBILITIES

A. Product Data will be received by the Construction Manager, logged, and provided to Owner as the Project record.

1. Product Data may be reviewed to see that the information provided is adequate for the purpose intended. Product Data not meeting the requirements of Paragraph 1.02 may not be approved.
2. Product Data is not reviewed for compliance with the Contract Documents. Comments may be returned if deviations from the Contract Documents are noted during the cursory review performed to see that the information is adequate.
3. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the review of Product Data. Contract modifications can only be approved by a Change Order or Field Order.

B. Construction Manager may take the following action in processing Product Data:

1. File Product Data as received if the cursory review indicates that the document meets the requirements of Paragraph 1.02. Document will be marked "Filed as Received" and "Documents Filed." No further action is required on that Product Data.
2. Not approve the Product Data for one of the following reasons:
 - a. The documentation requirements of the Contract Documents indicate that the document submitted as Product Data should have been submitted as a Shop Drawing. The Product Data will be marked "Not Approved" and "Submit as Shop Drawing." No further action is required on this document as Product Data and the Product Data process will be closed. Resubmit the document as a Shop Drawing per Section 01_33_02 Shop Drawings.
 - b. The cursory review indicates that the document does not meet the requirements of Paragraph 1.02. The Product Data will be marked "Not Approved" and "Revise and Resubmit." Contractor is to resubmit the Product Data until it is acceptable and marked Filed as Received. When Product Data is filed, no further action is required, and the Product Data process will be closed.
 - c. The Product Data is not required by the Contract Documents nor is applicable to the Project. The Product Data will be marked "Not Approved" and "Cancelled." No further action is required, and the Product Data process will be closed.

- C. Contractor is to resubmit the Product Data until it is acceptable and marked "Filed as Received."

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_33_04 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

- A. Prepare a complete and detailed operation and maintenance manual (manual) for each type and model of equipment or product furnished and installed under this Contract.
- B. Prepare manuals in the form of an instruction manual for the Owner. The manuals are to be suitable for use in providing the operation and maintenance instructions required by Section 01_79_00 Training of Operation and Maintenance Personnel.
- C. Provide complete and detailed information specifically for the products or systems provided for this Project. Include the information required to operate and maintain the product or system.
- D. Manuals are to be provided in addition to any information packed with or attached to the product when delivered. Remove information packed with or attached to the product and include this information as an attachment to the manual.
- E. Include cost for manuals provided by Suppliers and Subcontractors as described in this Section in the Cost of Work for that equipment item.

1.02 DOCUMENTATION

- A. Submit manuals in accordance with Section 01_33_00 Document Management. Attach a copy of the Operation and Maintenance Manual Review Report form provided by the Construction Manager to each manual with pertinent information completed.
- B. Provide one preliminary electronic copy of the manual to the Construction Manager for review within 15 days after review of any equipment submittal by the OPT.
- C. Provide one electronic copy and three printed copies of the final manual after:
 - 1. Preliminary manuals have been approved;
 - 2. Field test records have been incorporated into the manual; and
 - 3. Record Documents per Section 01_31_13 Project Coordination have been approved and have been incorporated in the final manual.
- D. Provide copies of the manufacturer's warranties, guarantees, or service agreements in accordance with Section 01_70_00 Execution and Closeout Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide electronic files for each manual as specified in Paragraph 2.02.
 - 1. Use filenames that correspond to the equipment designation shown in the Contract Documents or other equipment designations provided by the OPT.
 - 2. Submit a preliminary version of the electronic manual for review. Provide a final version of the manual incorporating OPT's comments.

- B. Provide 3 printed copies of each manual as specified in Paragraph 2.03.

2.02 ELECTRONIC MANUAL FORMAT

- A. Manual contents are to be submitted in electronic format to the Construction Manager.
- B. Provide individual electronic files for each manual.
 - 1. Maximum file size is 75 MB. If manual is greater than maximum allowable file size, provide individual files for each major section of manual.
 - 2. Acceptable file types for written documents are Portable Document File (PDF) or provide manual text in Microsoft Word. Provide drawings in native format and PDF format. All files must be compatible with the latest software version available.
 - 3. Filename must identify the equipment location, equipment manufacturer, and date equipment placed in service, e.g. Pump Room-Manufacturer-200503.pdf.
 - 4. Each electronic file must contain a table of contents at the beginning of the file which includes hypertext links or bookmarks to navigate the file contents per section/chapter.
 - 5. Scanned images of written documents are not acceptable. Document must allow character selection. Text within a file must be transferable to other documents.
 - 6. Drawing files must have the ability to turn on/off drawing layers within the file.

2.03 PRINTED MANUAL FORMAT

- A. Printed copies of each manual are to be submitted as follows:
 - 1. Print manuals on heavy, first quality 8-1/2 x 11 paper.
 - a. Reduce drawings and diagrams to 8-1/2 x 11 paper size.
 - b. When reduction is not practical, fold drawings and place each separately in a clear, super heavy weight, top loading polypropylene sheet protector designed for three-ring binder use. Provide a typed identification label on each sheet protector.
 - c. Punch paper for standard three-ring binders.
 - 2. Place manuals in heavy duty presentation, d-ring binders with clear front, back, and spine covers.
 - 3. Identify each manual by placing a printed cover sheet in the front cover of the binder and as the first page in the manual. The first page is to be placed in a clear polypropylene sheet protector. The information on first page and the cover page are to include:
 - a. Name of Owner;
 - b. Project name;
 - c. Volume number; and
 - d. Table of contents.
 - 4. Insert the name of the Project and volume number into the spine covers.

5. Sheet lifters are to be provided.
6. Minimum size is 2-inch capacity. Maximum size is 3-inch capacity. Fill binders to only three-fourths of its indicated capacity to allow for addition of materials to each binder by the Owner.
7. Provide index tabs for each section of the manual. Indexes are to be constructed of heavy-duty paper with a reinforced binding edge. The designation on each index tab is to correspond to the number and letter assigned in the Table of Contents.
8. Manuals for several products or systems may be provided in the same binder. Correlate the data into related groups when multiple products or systems are included in the same binder.
 - a. Sections for each product or system must be included in the same binder.
 - b. Sections must be in numerical order from volume to volume.

PART 3 - EXECUTION

3.01 MANUAL ORGANIZATION AND CONTENTS

- A. Provide a table of contents listing each section of the manual for each product or system.
 1. Assign a number and letter to each section in the manual.
 - a. The number is to correspond to the Owner's equipment numbering system or other system designated in the Contract Documents.
 - b. The letter assigned will represent the part of the manual, consistent with the manual contents as required by this Section.
 2. Identify each product or system using the nomenclature shown in the Contract Documents. Provide a cross reference to the Owner's numbering system and designations for equipment indicated in the Contract Documents if these are different.
- B. Include only the information that pertains to the product described. Annotate each sheet to:
 1. Clearly identify the specific product or component installed;
 2. Clearly identify the data applicable to the installation; and
 3. Delete or strike through references to inapplicable information.
- C. Supplement manual information with drawings as necessary to clearly illustrate relations of component parts of equipment and systems, and control and flow diagrams.
- D. Manuals for several products or systems may be provided in the same binder.
- E. Fill binders to only three-fourths of its indicated capacity to allow for addition of information by the Owner.

3.02 EQUIPMENT AND SYSTEMS MANUAL CONTENT

- A. Provide the following information in the first tabbed section of each manual:
 1. A description of the unit and component parts and how it functions.

2. Operating instructions for pre-startup, startup, normal operations, regulation, control, shutdown, emergency conditions, and limiting operating conditions.
 3. The sequence of operation by the control's manufacturer. Provide control diagrams by the manufacturer, modified to reflect the as-built, as-installed condition.
 4. Include general assembly contract drawings, sections, and photographic views as necessary to completely depict and properly identify the equipment. Indicate the dimensions, weight, capacity, and design conditions for the equipment.
- B. Include detailed information to allow for the proper installation, calibration, testing, preventative, and corrective maintenance procedures in the second section of the manual or of each section of the manual information if the manual covers a multi-component equipment system. This information should include the following:
1. Maintenance instructions including assembly, installation, alignment, clearances, tolerances, and interfacing equipment requirements, adjustment, and checking instructions. Include any special rigging required to place the equipment into place, and any special test equipment required to place the equipment in service.
 2. A safety subsection which addresses all safety and tag-out procedures necessary to safely operate and maintain the equipment.
 3. Lubrication schedule and lubrication procedures. Include a cross reference for recommended lubrication products.
 4. Troubleshooting guide.
 5. A table showing the schedule of routine maintenance requirements and seasonal work which is not performed at a set frequency. Preventative maintenance tasking must address:
 - a. Daily/weekly inspections performed by operations personnel;
 - b. Routine preventative maintenance scheduled weekly, monthly, quarterly, semi-annually, or annually through major overhauls by maintenance personnel; and
 - c. Predictive maintenance work such as alignment, analysis of the equipment, vibration, flow, oil sampling, etc.
 6. Description of sequence of operation by the control manufacturer.
 7. Warnings for detrimental maintenance practices.
 8. Detailed corrective maintenance procedures including:
 - a. Detail equipment for complete disassembly and assembly;
 - b. Cross-sectional drawings or exploded views with all parts numbered to correspond with the numbers in the parts list to permit identification of the various parts;
 - c. A table of normal clearances, diameters, thickness of new parts, and limits permissible for wearing parts; and
 - d. List torque settings for nuts, bolts, and fasteners when critical to the equipment's performance.

- C. Include all necessary diagrammatic piping and wiring diagrams and miscellaneous contract drawings and equipment in the third section of the manual or of each section of the manual if the manual covers a multi-component equipment system.
- D. Provide spare parts information in the fourth section of the manual including:
 - 1. Part numbers for ordering new parts;
 - 2. Assembly illustrations showing an exploded view of the complex parts of the product;
 - 3. Predicted life of parts subject to wear;
 - 4. List of the manufacturer's recommended spare parts, current prices with effective date, and number of parts recommended for storage;
 - 5. Directory of a local source of supply for parts with company name, address, and telephone number;
 - 6. Complete nomenclature and list of commercial replacement parts; and
 - 7. Complete list of spare parts, spare equipment, tools, and materials that are turned over to the Owner.
- E. Provide statistical information from the original equipment manufacturer as to performance such as pump curves, flow charts insulation resistance, calibration, or test data sheets in the fifth section of the manual, including all field-testing records used to verify actual performance.
- F. Provide equipment name plate data installed on equipment and valves and equipment data sheets as required and furnished by the Owner in the sixth section of the manual.
- G. Provide a copy of warranties and the date the warranty expires for equipment in the seventh section of the manual.

3.03 ELECTRICAL AND ELECTRONICS SYSTEMS MANUAL

- A. Provide all the information listed in Paragraph 3.02 as appropriate and include the following information:
 - 1. Control schematics and point to point wiring diagrams prepared for field installation;
 - 2. Circuit directories of panel boards and terminal strips and as installed color-coded wiring diagrams; and
 - 3. Other information as may be required by the individual Specification Sections.

3.04 ARCHITECTURAL PRODUCTS MANUAL

- A. Provide the following information:
 - 1. Information required for ordering replacement products;
 - 2. Instructions for care and maintenance;
 - 3. List of the manufacturer's recommended lubricants;
 - 4. The manufacturer's recommendations for types of cleaning agents and methods;

- 5. Cautions against cleaning agents and methods that are detrimental to the product;
and
- 6. Recommended maintenance and cleaning schedule.
- B. Final balancing reports for mechanical systems.
- C. Other information as may be required by the individual Specification Sections.

3.05 LIST OF SERVICE ORGANIZATIONS

- A. Provide a directory of authorized service organizations with company name, address, telephone number, email address, and the contact person for warranty repair.

END OF SECTION

01 33 05 CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1.01 SUMMARY

- A. Prepare and submit schedules for the Work and update the schedule at their prescribed frequency for the duration of the Project.
- B. Provide schedules in adequate detail to establish a baseline for construction progress, to allow OPT to monitor progress, and to relate submittal processing to sequential activities of the Work. Progress schedule is to be in adequate detail to:
 - 1. Demonstrate adequate planning, scheduling, and provide reporting during the execution of the Work;
 - 2. Demonstrate the coordination of the Work of the Contractor and the various Subcontractors and Suppliers;
 - 3. Monitor the progress of the Work; and
 - 4. Evaluate the impact of proposed changes to the Contract Times and Project schedule.
- C. Incorporate Contract Milestones into the schedule and show activities leading to achievement of these milestones.
- D. Assume complete responsibility for maintaining the progress of the Work per the schedules submitted.
- E. Failure to submit schedules may cause delays in the review and approval of subsequent Applications for Payment.

1.02 REQUIRED SCHEDULE TYPES

- A. Near-Term Look Ahead Schedule
 - 1. Provide Near-Term Look Ahead (NTLA) Schedules using the Excel spreadsheet form provided by the Construction Manager, or other form acceptable to the Construction Manager, to serve as a preliminary schedule until the Baseline Schedule is accepted. Update this NTLA Schedule every two weeks until the Baseline Schedule is accepted. The NTLA Schedule must include planned activities for the following:
 - a. Anticipated weather conditions.
 - b. Submittals to be provided and day of anticipated return.
 - c. Deliveries of equipment and material to be incorporated into the Work.
 - d. Arrival and departure of key construction equipment.
 - e. Changes in CONTRACTOR and Subcontractor personnel.
 - f. Activities for the CONTRACTOR and each Subcontractor.
 - 1) Indicate the beginning of each activity,
 - 2) End of each activity, and

- 3) Key activities and milestones such as concrete placements, setting key equipment components, delivery of critical deliveries and key elements in a Plan of Action submitted per Section 01_31_13 Project Coordination.
 2. Once the Baseline Schedule has been accepted, provide a NTLA Schedule for with each progress meeting and with the CONTRACTOR's Monthly Report. Schedule period should include the week preceding the progress meeting and extend for one week beyond the next schedule progress meeting.
 3. Coordinate NTLA Schedule with Progress Schedule. Submit a report with the Contractor's Monthly Report identifying deviations from the Project Schedule.
 4. Submit a report of near-term work planned in the previous NTLA Schedule that was delayed or not executed by marking actual activity on the previous NTLA Schedule. Provide explanation of why planned work was not executed and the plan for executing this work in the future to regain time lost. Include this information in the Contractor's Monthly Progress Report.
- B. Baseline Schedule
1. Provide a Baseline Schedule that reflects the anticipated schedule for construction and completion of the Project based on more detailed information obtained after the Notice to Proceed.
 2. Once this Baseline Schedule is accepted by the Construction Manager it will serve as the baseline for schedule updates and Recovery Schedules. It will be used to assess on-time performance, to determine if a Recovery Schedule is required and if requirements for an extension of Contract Times by Change Order or Contract Amendment have been met.
 3. Provide a narrative report discussing:
 - a. Schedule logic.
 - b. Resources to be used and the basis for activity durations.
 - c. Identified schedule constraints.
 - d. Description of the Critical Path.
 - e. Risk factors that could create delays in completing the Project within Contract Times.
- C. Progress Schedules
1. Provide a Progress Schedule each month to show the progress made to date. Base the Progress Schedule on the accepted Baseline Schedule or currently accepted Recovery Schedule. Schedule updates are to be based on retained logic. Progress logic is not allowed in any schedule.
 2. Provide a dateline on the schedule as of the end of the previous month and indicate which activities have started, the percent complete based on earned value for ongoing activities and which activities are complete.
 3. Provide a narrative report discussing:
 - a. Description of the current progress and status for each area of the Project.

- b. Description of progress for the period.
 - c. Proposed changes in schedule logic or identified schedule constraints.
 - d. Changes in resources to be used and the basis for revised activity durations.
 - e. Changes in the Critical Path for the Project.
 - f. Potential delays in completing the Project within Contract Times.
 - g. Impacts of Change Orders approved or pending since the previous Progress Schedule.
 - h. Other issues that might impact the ability to complete the Project within Contract Times.
4. Identify activities which appear to be behind schedule, why they are behind schedule, available float, if any, and actions to be taken to bring that activity back on schedule.
- D. Recovery Schedules
- 1. Provide a Recovery Schedule within 30 days if it appears that the Baseline Schedule no longer represents the actual progress of the Work, if actual progress indicates the CONTRACTOR is more than 30 days behind schedule, or it appears the CONTRACTOR may fail to meet a specified Milestone.
 - a. Submit a Plan of Action for schedule recovery that includes:
 - 1) Analysis of the projected number of days the Project is behind schedule.
 - 2) Narrative description of the steps to be taken to bring the Project back on schedule.
 - 3) Anticipated time required to bring the Project back on schedule.
 - b. Submit a Recovery Schedule showing the actions to be taken to complete the Project on the dates shown in the Baseline Schedule.
 - 2. A Recovery Schedule is not required if Contractor can demonstrate to the satisfaction of the Construction Manager that there is an excusable delay, Change Order or Work Change Directive that will merit a change in the Contract Time in excess of the number of days the Project appears to be behind schedule.
 - 3. Updating the Progress Schedule to reflect actual progress is not considered a Recovery Schedule.
 - 4. Payment Requests may not be recommended for payment without a Plan of Action and Recovery Schedule indicating the Contractor's plan for bringing the Project back on schedule.
- E. Impact Schedule for Changes in Contract Times
- 1. Prepare and submit an Impact Schedule when a Change Proposal is prepared, or a Work Change Directive is issued per Section 01_26_00 – Change Management that will affect the Progress Schedule to quantify the time impact on the Contract Times.
 - 2. The time impact analysis is to include a diagram of the fragment of the schedule network (fragnet) illustrating the schedule for the change, and how this fragnet fits

into the Baseline Schedule or accepted Recovery Schedule logic. The fragnet is to incorporate all the requirements for the Baseline Schedule.

3. The time impact analysis is to clearly demonstrate the impact of the change in the schedule and the resulting impact on the Contract Times based on activity durations, date of implementation, status of Work on the project when implemented.
4. Construction Manager will deem any Change Proposal that does not have a revised Progress Schedule and request for a change in Contract Times as having no impact on the ability of the Contractor to complete the Project within the Contract Times.

F. Schedule Revisions for Changes in Contract Times

1. Revise the Baseline Schedule and Recovery Schedules to indicate any adjustments in Contract Times approved by a Change Order or Contract Amendment.

1.03 SCHEDULER QUALIFICATIONS

A. Near Term Look Ahead Schedules

1. NTLA Schedules can be prepared by project managers, project engineers or project superintendent that have a working knowledge of the Project. Coordinate this collaborative effort for NTLA Schedules with the scheduler preparing the Baseline and other project schedules.

B. Critical Path Method Schedules

1. Provide personnel with 5 years' minimum experience in scheduling construction work comparable to this Project using the specified Critical Path Method (CPM) software.
2. Submit resumes of proposed CPM scheduling personnel to demonstrate they meet the requirements of this Paragraph. Resumes must include a list of at least 5 similar projects and include references for these projects.
3. Construction Manager has 10 days following the submission of this information to review the qualifications of the proposed CPM scheduler. If Construction Manager has not indicated acceptance or an objection to the CPM scheduler within 10 days, the proposed CPM scheduler is deemed acceptable.
4. If during the project it becomes apparent to the Construction Manager that the CPM scheduler is not capable of providing acceptable CPM schedules within prescribed times, Contractor is to engage other personnel meeting the qualifications of this Paragraph.

1.04 DOCUMENTATION

- A. Submit the schedules to the Construction Manager per Section 01_33_00 Document Management. Send all documents in digital format for processing.
- B. Provide schedules, schedule updates and revisions to the Construction Manager in Portable Document Format (PDF) and in electronic format in their originating software.
 1. Prepare PDF copies of schedule suitable for review on screen and for producing printed documents that are legible when printed on 11 inches by 17 inches paper. Contractor is to provide printed copies if the Construction Manager agrees to provide

printed copies in a different size or format. Include the following columns in the document:

- a. Activity ID.
- b. Activity Name.
- c. Actual Duration.
- d. Remaining Duration.
- e. Total Float.
- f. Start Date.
- g. Finish Date.

2. Submit an (.xer file) of the schedule

- C. Submit a Baseline Schedule per Paragraph 1.02.B no more than 60 days after the Notice to Proceed.
- D. Submit Progress Schedules per Paragraph 1.02.C monthly within 10 days after each Payment Request to indicate the progress made on the Project to the closing date for the Payment Request.
- E. Submit a Recovery Schedule per Paragraph 1.02.D if actual progress indicates the Contractor is behind schedule.
- F. Submit an Impact Schedule per Paragraph 1.02.E with any Change Proposal where a change in Contract Times or an impact to a contract Milestone is proposed.

1.05 CRITICAL PATH METHOD SCHEDULE REQUIREMENTS

- A. Participate in schedule workshops prior to developing the Baseline Schedule to discuss schedule requirements and schedule review procedures. Participate in other workshops as requested by the Construction Manager to review Progress Schedules or Recovery Schedules.
- B. Provide CPM schedule in the form of a computer-generated critical path schedule using Primavera P6 Software, Version 6.2, or later software, unless other scheduling software is acceptable to Construction Manager. It is intended that the schedule accomplish the following:
 1. Give early warning of delays in time for correction.
 2. Provide detailed plans for the execution of the Work in the form of future activities and events in sequential relationships.
 3. Establish relationships between significant planned Work activities and provide a logical sequence for planned Work activities.
 4. Provide continuous status information.
 5. Allow analysis of the Contractor's program for the completion of the Project.
 6. Permit schedules to be revised when the existing schedule is not achievable.
 7. Log the progress of the actual Work completed.

- C. Schedule activities are to incorporate time for the following:
1. Mobilization and demobilization.
 2. Contractor management functions.
 3. Anticipated Request for Information, allowing time for a response.
 4. Submittal review process per Paragraph 1.05.G.
 5. Time for fabrication and delivery of materials and equipment.
 6. Dates for delivery and installation of Owner furnished equipment or products.
 7. Dates identified for acceptance of systems by Owner for early beneficial use or occupancy.
 8. Productivity of available resources.
 9. Site conditions and physical restrictions associated with the Work.
 10. Factory or on-site testing for performance and quality.
 11. Work of Subcontractor and Suppliers.
 12. Availability of Contractor's resources including labor, equipment, and construction materials.
 13. Availability of other resources.
 14. Weather conditions per Paragraph 1.07.
 15. Start-up and initial operation requirements per Section 01_75_00 Starting Facilities and Initial Operations.
 16. Performance acceptance testing.
 17. Coordination with OWNER's operations.
 18. Special sequencing requirements per Section 01_35_00 Special Procedures.
 19. Periodic and final cleaning.
 20. Other factors that have the potential to impact completion of the Work within Contract Times.
- D. Provide sub-groups for:
1. Submission and review of Submittals.
 2. Delivery of process equipment and key materials.
 3. Incorporate Interface Milestones/Tasks into the schedule such as shutdown, tie-ins schedule and interdependencies of the projects. Use the unique IDs of the Interface Milestones/Tasks that will be provided by the Owner.
 4. Issues, impacts and Change Orders'
 5. Work areas process, structure, or type of work.

- E. Provide a time-scaled horizontal bar chart which indicates graphically the Work scheduled at any time during the Project. The chart is to indicate:
 - 1. Complete sequence of construction by activity;
 - 2. Identification of the activity by structure, location, and type of Work;
 - 3. Chronological order of the start of each item of Work;
 - 4. Each activity start and stop dates;
 - 5. Each activity duration; and production rates used to determine the duration;
 - 6. Successor and predecessor relationships for each activity;
 - 7. A clearly indicated single critical path; and
 - 8. Projected percentage of completion based on dollar value of the Work included in each activity as of the first day of each month.
- F. Interface Milestones Management
 - 1. Incorporate an "Interface Milestones/Tasks" category into the schedule to reflect activities from shutdown schedules, tie-ins schedule and other interdependencies of the projects.
 - 2. Use the unique IDs of the Interface Milestones/Tasks that will be provided by the Owner.
 - 3. Establish unique project IDs for each project.
 - 4. Attend quarterly (or as necessary) interface milestone meeting with the Owner.
- G. Incorporate Submittals in Schedules:
 - 1. Indicate the specific dates each document is to be delivered to the Construction Manager.
 - 2. Allow a reasonable time for review of each document, considering the size and complexity of the document, other documents being processed, and other factors that may affect review time.
 - 3. Include time for revising the Shop Drawings and resubmitting the Shop Drawing for at least a second review.
 - 4. Assume a 14-day review cycle for each time a Shop Drawing is submitted for review unless a longer period is indicated in the Contract Documents or provided by the Construction Manager.
 - 5. Contractor is responsible for delays associated with additional time required to review incomplete or erroneous documents and for time lost when documents are submitted for products that do not meet specification requirements.
- H. Scheduling Technical Specifications.
 - 1. Prepare Progress Schedule using Primavera P6 Software, Version 6.2, or later software, unless other scheduling software is acceptable to Construction Manager.
 - 2. Align the Work Breakdown Structure (WBS) with the Construction Document sequencing plan

3. Calculate critical path based on "Longest Path"
4. All calendars assigned to activities should be "Project" calendar
5. The finish date of a predecessor cannot be the same as the start date of the successor activity in a "Finish-to-Start" relationship
6. "Retained logic" is the required mode for critical path calculation.
7. Data Date must be the last day of the month at 23:50.
8. The "Must Finish By" date must be blank.
9. No open-ended activities are allowed except the project start, project finish and interfacing milestones.
10. Activities must not have negative lags.
11. Activities with a lag greater than 10 days in a "Finish-to-Start" relationships are not allowed.
12. Activities must not have relationship type Start-to Finish (SF)
13. Mandatory Start, Mandatory Finish, Start On & Finish On "Constraints" are not allowed.
14. "Out of Sequence" activities are not allowed
15. No activity should have an actual Date greater than Data Date

I. Tabulation of Values

1. Provide a table of values for each Activity shown in the CPM schedule which includes the following values:
 - a. Activity number.
 - b. Activity description.
 - c. Activity duration in workdays.
 - d. Early Start date (calendar date).
 - e. Early Finish date (calendar date).
 - f. Late Start date (calendar date).
 - g. Late Finish date (calendar date).
 - h. Float of each Activity.
 - i. Critical Path activities indicated.

1.06 FLOAT TIME

- A. Define total float time as the amount of time between the earliest start date and the latest start date of a chain of activities on the construction schedule.
- B. Total float time is not for the exclusive use or benefit of either the Contractor or Owner and may be used by either for changes in the Work or mitigate the effect of delays which might otherwise impact the ability to complete the project within Contract Times.

- C. Where several subsystems each have a critical path, the subsystem with the longest time of completion is the critical path and float time is to be assigned to other subsystems.
- D. Schedule completion dates must be the same as the Contract completion dates. Should the Contractor's schedule indicate completion dates earlier than the specified Contract Times, float will be added to the end of the schedule, so the Contractor's schedule completion dates equal the specified Contract Times.

1.07 DELAYS IN CONTRACTOR'S PROGRESS

- A. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delays, disruptions, or interference caused by or within the control of Contractor.
- B. Contractor is entitled to an equitable adjustment in Contract Price or Contract Times if Owner directly delays, disrupts, or interferes with the performance or progress of the Work and the critical path is impacted. Contractor is not entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of the Owner if this delay is concurrent with a delay, disruption, or interference attributable to or within the control of the Contractor's Team.
- C. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner or Contractor that result in a change to the critical path. These adjustments in Contract Times are the Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. These unanticipated causes include:
 - 1. Severe and unavoidable natural catastrophes e.g. fires, floods, epidemics, and earthquakes.;
 - 2. Abnormal weather conditions per Paragraph 1.5.D.
 - 3. Acts of war or terrorism.
 - 4. Acts or failures to act of utility owners or other third-party entities other than those third-party utility owners performing other work at or adjacent to the Site as arranged by the Owner.
 - 5. Delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site unless this other work also for the Owner.
- D. Contractor is to include time associated with normal weather-related delays in the Baseline Schedule and assume the risks, including costs, associated with delays related to normal weather conditions. Contractor is entitled to an equitable adjustment in the Contract Times, but not Contract Price, if Contractor's performance or progress is delayed or disrupted by abnormal weather conditions. Abnormal weather conditions exist when the number of bad weather days for a given month exceed the number of anticipated bad weather delays per month indicated in the table below:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	4	4	5	4	2	2	3	4	3	3

1. Bad weather days are determined on a month by month basis in accordance with the following:
 - a. Total precipitation occurring between midnight on the preceding day (regardless of whether such preceding day is a workday) through midnight on the workday in question equals or exceeds 0.25 inches of precipitation.
 - b. Ice or snow at the site make working conditions hazardous.
 - c. Heat index at 3:00 p.m. falls into the Extreme Risk Category per NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments and working hours cannot be adjusted to avoid exposure to heat.
 2. Every bad weather day exceeding the number of bad weather days for each month established in Paragraph 1.5.D will be considered as abnormal weather conditions. The existence of abnormal weather conditions will not relieve Contractor of the obligation to demonstrate and document that delays caused by abnormal weather are specific to the planned work activities or that such activities thus delayed were on Contractor's then-current Progress Schedule's critical path for the Project.
 3. Determination of actual bad weather days during performance of the Work will be based on the weather records measured and recorded by the National Oceanic and Atmospheric Administration (NOAA) weather monitoring station at Dallas Fort Worth International Airport. Local measurements from rain gages and thermometers at the Site may be used with approval of the Construction Manager provided these instruments meet NOAA standards for such devices.
 4. A request for an equitable adjustment in the Contract Times based on abnormal weather conditions must be documented by data substantiating that weather conditions classified as bad weather days exceeded the number of days specified for the month in which they occur and such weather conditions had an adverse effect on the Work as scheduled.
 5. Incorporate "bad weather days" into the Monthly Progress Schedule and submit with other required documentation. Schedule construction so that the Work will be completed within the Contract Times assuming that these "bad weather days" will occur. Incorporate residual impacts following "bad weather days" such as limited access to and within the Site, inability to work due to wet or muddy Site conditions, delays in delivery of equipment and materials and other impacts related to precipitation days when developing the schedule for Construction. Include all costs associated with these precipitation days and residual impacts in the Contract Price.
 6. Incorporate bad weather days as a line item in the schedule. Unused bad weather days in each month will be considered float time which may be consumed by the Owner or Contractor in delay claims.
- E. Contractor is only entitled to an adjustment of the Contract Times for specific delays, disruptions, and interference to the performance or progress of the Work that can be demonstrated to directly impact the ability of the Contractor to complete the Work within the Contract Times. No adjustments in Contract Times are allowed for delays on components of the Work which were or could have been completed without impacting the Contract Times. No adjustments are allowed for delays in activities that have schedule float

unless the number of float days are exceeded, and the critical path is extended by the activity.

- F. Notify the Construction Manager immediately of a potential delaying, disrupting, or interfering event. Submit a Change Proposal seeking an adjustment in Contract Price or Contract Times within 30 days of the delaying, disrupting, or interfering event. Adjustments of Contract Times or Contract Price are subject to the provisions of Section 01_26_00 Change Management. Change Proposals seeking an increase in Contract Times or Contract Price submitted must include supporting data that details the following:
1. The circumstances that form the basis for the requested adjustment.
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work.
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work.
 4. The number of days' increase in Contract Times claimed because of each such cause of delay, disruption, or interference.
 5. A revised Progress Schedule indicating all the activities affected by the delay, disruption, or interference.
 6. An explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.
 7. The impact on Contract Price, in accord with the provisions of Section 01_26_00 Change Management.
 8. Such additional supporting documentation as Construction Manager may require.

1.08 MODIFICATION OF CONTRACT TIMES

- A. Contract Times cannot be changed by the submission of a schedule. Contract Times can only be modified by a Change Order or Contract Amendment, which will establish a revised contract Baseline Schedule. Contractor may submit a schedule showing completion dates earlier than Contract times with the provision and understanding that Contractor is not entitled to submit a Change Proposal or Claim if it fails to complete the Work by the earlier dates indicated in accepted schedules.
- B. Submit a Change Proposal for any proposed change in Contract Times and include justification for the change in accordance with the provisions of the Contract Documents Including an Impact Schedule per Paragraph 1.02.E.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_40_00 QUALITY MANAGEMENT

PART 1 - GENERAL

1.01 OVERVIEW

- A. Quality management refers to the overall process of delivering a completed Project to the Owner that complies with the requirements of the Contract Documents. Quality management applies to documentation, products, services, and the Work.
- B. The Contractor is responsible for the quality of documentation, products, services, and the Work provided.
 - 1. Contractor is to integrate quality control procedures into the execution of the Work that are adequate to produce a Project that meets the requirements of the Contract Documents while minimizing loss of time and increased cost. Contractor is solely responsible for time and cost impacts of correcting Defective Work.
 - 2. Contractor is to provide all testing and inspection required to control the quality of the Work in progress to determine that completed Work will comply with the requirements of the Contract Documents.
 - 3. Contractor is to provide verification or acceptance testing as required by the Contract Documents to demonstrate that the completed Work complies with the requirements of the Contract Documents, except for those test that the OPT has determined are to be conducted independent of the Contractor and identified as OPT testing in the Owner's Quality Management Plan.

1.02 STANDARDS

- A. Provide testing laboratories that comply with the American Council of Independent Laboratories (ACIL) "Recommended Requirements for Independent Laboratory Qualifications."
- B. Perform testing per recognized test procedures as listed in the various Sections of the Specifications, standards of the State Department of Transportation, ASTM International (American Society for Testing and Materials), or other testing associations. Perform tests in accordance with published procedures for testing issued by these organizations.

1.03 DOCUMENTATION

- A. Provide documentation which includes:
 - 1. Contractor's Quality Management Plan that establishes the methods of ensuring compliance with the Contract Documents. Submit this plan as Product Data per Section 01_31_13 Project Coordination.
 - 2. A statement of qualifications for any proposed testing laboratory that includes a list of the engineers and technical staff that will provide testing services on the Project, descriptions of the qualifications of these individuals, list of tests that can be performed, equipment used with date of last certification, and a list of recent projects for which testing has been performed with references for those projects.

3. Certified Test Reports for products to be incorporated into the Project. Provide reports to indicate that the proposed products comply with the Contract Documents or indicate that the proposed products do not comply with the Contract Documents and why those products do not comply. Submit Certified Test Reports as part of a Shop Drawing submitted per Section 01_33_02 Shop Drawings.
4. Certified Test Reports for inspections and testing required in this Section and in other Sections of the Specifications. Provide reports to indicate that the Work complies with the Contract Documents or indicate that the Work does not comply with the Contract Documents and why the Work does not comply. Submit these test reports on forms provided by the Construction Manager per Section 01_33_00 Document Management.
5. Certified Test Reports of Defective Work and Certified Test Reports documenting that successful corrective action has produced Work that complies with the Contract Documents. Construction Manager will maintain a Defective Work register. Progress on correction of Defective Work will be discussed at progress meetings as described in Paragraph 1.05.E. The final Defective Work register will be incorporated into closeout documentation required per Section 01_70_00 Execution and Closeout Requirements as a record that all Defective Work has been corrected.
6. Certified Test Reports of Defective Work and Certified Test Reports documenting that successful corrective action has produced Work that complies with the Contract Documents. Maintain a register listing Defective Work and record when corrective action has produced Work that complies with the Contract Documents. Present this Defective Work register as part of the Quality Report at progress meetings as described in Paragraph 1.05.E. Incorporate this register in the closeout documentation per Section 01_70_00 Execution and Closeout Requirements to demonstrate that all Defective Work has been corrected.

1.04 OWNER'S QUALITY MANAGEMENT ACTIVITIES

- A. OPT may perform its own verification testing independent of the Contractor. Actual testing will depend on the Contractor's means, methods, and procedures of construction which will not be known until the Contractor submits the Contractor's Quality Control Plan (CQCP) to the OPT. There is no guarantee that all testing in the preliminary OQMP included in the Bidding/Proposal Documents will be performed by the OPT. Contractor will arrange and pay for all production control testing deemed necessary by the Contractor to produce quality results.
- B. Quality management activities of the OPT are for verifying the results of the Contractor's Work complies with the requirements of the Contract Documents. Performance or non-performance of verification activities by the OPT:
 1. Does not relieve the Contractor of its responsibility to provide Work and furnish products that comply with the requirements of the Contract Documents;
 2. Does not relieve the Contractor of its responsibility to provide adequate quality control measures to produce quality documents, products, services, or Work;
 3. Does not relieve the Contractor of its responsibility for damage to or loss of Work or products before OPT's acceptance; and

4. Does not affect the continuing rights of the Owner after OPT's acceptance of the completed Work.
- C. The Work is subject to OPT's observations or testing at any time. Products which have been tested or inspected and accepted by the OPT at a supply source or staging area may be inspected or tested again by the OPT before, during, or after incorporation into the Work and rejected if products do not comply with the Contract Documents. Verification testing performed by the OPT will be paid for by the Owner, except for testing related to Defective Work as discussed in Paragraph 3.03.

1.05 CONTRACTOR'S RESPONSIBILITIES

- A. Review the OQMP and provide a Contractor's Quality Control Plan (CQCP) outlining testing to be provided by the Contractor per Paragraph 1.07.
- B. Implement the CQCP to provide Work that complies with the requirements of the Contract Documents.
 1. Provide quality documents meeting the requirements of the Contract Documents.
 2. Provide services meeting the requirements of the Contract Documents.
 3. Provide the services of a Construction Materials Inspection and Testing (CMIT) provider meeting the requirements of this Section to provide testing required by the Contract Documents to demonstrate that products proposed for the Project in Shop Drawings and Product Data fully comply with the Contract Documents.
 4. Inspect and test products to be incorporated into the Project to identify defects before installing them. Do not install Defective products. Conspicuously mark Defective products and remove from the Site. If products are installed before the defect is recognized, remove the Defective products, mark them as Defective and remove them from the Site when the defect is recognized.
 5. Integrate production quality control measures into construction activities to produce Work meeting the requirements of the Contract Documents. Inspect self-performed Work and the Work of Subcontractors and Suppliers to identify defects. Correct or replace Defective Work.
 6. Provide facilities, equipment, and Samples required for inspections and tests.
 - a. Give the Construction Manager adequate notice before proceeding with Work that would interfere with inspections or testing.
 - b. Notify the Construction Manager and CMIT provider prior to the time that testing is required, providing adequate lead time to allow arrangements for inspections or testing to be performed.
 - c. Do not proceed with Work that would impact the ability to correct defects, or with Work that would require that it be removed to correct defects, until testing is complete, and test results indicate that the corrected Work is acceptable.
 - d. Provide safe access for all CMIT activities, including those to be conducted as part of the Owner's Quality Management Program.

- e. Cooperate fully with the performance of sampling, inspection, and testing. Provide personnel to assist with sampling or to assist in making inspections and field tests.
 - f. Provide Samples and products in adequate quantities for testing at the Site or at the production source of the product for testing.
 - g. Provide facilities required to store and cure test Samples.
 - h. Provide calibrated scales and measuring devices for OPT's use in performing inspections and testing.
 - i. Provide adequate lighting to allow OPT observations.
 - j. Make Contract Documents available to testing agencies when requested.
- C. Perform tests as indicated in Contract Documents. All verification testing is to be observed by the Construction Manager or its designated representative.
 - D. Submit test reports to the Construction Manager.
 - E. Provide an update on quality control activities performed the previous month and planned for the coming month at monthly progress meetings required by Section 01_31_13 Project Coordination.
 - F. Determine testing or inspections required to implement the CQCP. Include costs for additional testing and inspections required to meet Contractor's quality control obligations in the Contract Price.

1.06 CONTRACTOR'S QUALITY CONTROL MANAGER

- A. Provide a Quality Control Manager for the Project. The Quality Control Manager must have authority to reject Defective Work, redirect the efforts of the Contractor, Subcontractor and Suppliers to correct Defective Work and implement steps to prevent future Defective Work.

1.07 CONTRACTOR'S QUALITY CONTROL PLAN

- A. Provide a CQCP that describes testing and inspections for Work performed at the Site and at remote locations. Include Work by Subcontractors and Suppliers. The CQCP is to include:
 - 1. A description of the quality control organization, including an organization chart showing lines of authority to control the quality of Work;
 - 2. Documentation describing name, qualifications (in resume format), duties, responsibilities, and level of authority of the Quality Control Manager.;
 - 3. The name, qualifications (in resume format), duties, responsibilities, and authorities of other persons assigned a quality control function;
 - 4. Procedures for scheduling, reviewing, certifying, and managing documentation including documentation provided by Subcontractors and Suppliers;
 - 5. Control, verification, and acceptance testing procedures for each specific test. Include:
 - a. Name of tests to be performed,
 - b. Specification paragraph requiring test,

- c. Parameters of Work to be tested,
 - d. Test frequency,
 - e. Persons responsible for each test, and
 - f. Applicable industry testing standards and laboratory facilities to be used for the test;
- 6. Incorporate the testing specified in the OQMP into the CQCP, specifically identifying the tests or inspections that will be provided by the OQMP;
- 7. Procedures for tracking and documenting quality management efforts per Paragraph 1.03.
- 8. Reporting procedures which incorporate the use of forms provided by the Construction Manager.
- 9. The name of the proposed testing laboratories along with documentation of qualifications per Paragraph 1.03.
- B. Use the Contractor's Quality Control Plan Checklist provided by the Construction Manager to review the CQCP before submitting and include a copy of the completed checklist with the CQCP. Do not begin Work until the CQCP is accepted. Submit an interim plan covering only the portion of Work to be performed if the Contractor plans to begin Work prior to submitting the complete CQCP for the Project. Do not begin Work on other parts of the Project until the complete CQCP is accepted.
- C. Meet with the OPT 7 days after CQCP is submitted and before start of construction to discuss the CQCP.
- D. Notify the Construction Manager of any changes to the CQCP or quality control personnel.

1.08 CONTRACTOR'S USE OF OWNER'S TEST REPORTS

- A. Contractor will receive copies of all test reports documenting Owner's verification tests. Contractor is entitled to rely on the accuracy of these tests results and use these as part of its quality control efforts.
- B. Contractor may submit a Change Proposal if the Owner's testing program deviates significantly from the OQMP. Contractor must demonstrate that actual testing and inspection costs were incurred implementing the CQCP as a result of OPT's decision to not provide testing described in the OQMP.

1.09 LIMITATION OF AUTHORITY OF THE TESTING LABORATORY

- A. The testing laboratory representatives are limited to providing testing services and interpreting the results of the test performed.
- B. The testing laboratory is not authorized to:
 - 1. Alter the requirements of the Contract Documents;
 - 2. Accept or reject any portion of the Work;
 - 3. Perform any of the duties of the Contractor; or
 - 4. Direct or stop the Work.

1.10 TEST REPORTS

- A. Certified Test Reports are to be prepared for all tests.
 - 1. Tests performed by testing laboratories may be submitted on their standard test report forms if acceptable to the OPT using the process directed by the Construction Manager. These reports must include the following:
 - a. Name of the Owner, Project title and number, and name of the Contractor;
 - b. Name, address, and telephone number of the laboratory;
 - c. Name and signature of the laboratory personnel performing the test;
 - d. Description of the product being sampled or tested;
 - e. Date and time of sampling, inspection, and testing;
 - f. Date the report was issued;
 - g. Description of the test performed;
 - h. Weather conditions and temperature at time of test or sampling;
 - i. Location at the Site or structure where the test was taken;
 - j. Standard or test procedure used in making the test;
 - k. A description of the results of the test;
 - l. Statement of compliance or non-compliance with the Contract Documents; and
 - m. Interpretations of test results, if appropriate.
 - 2. Submit reports on tests performed by Contractor, Subcontractors, or Suppliers on the as directed by the Construction Manager.
 - 3. OPT will prepare test reports on tests performed by the OPT.
- B. Submit test reports as directed by the Construction Manager within 24 hours of completing the test. Flag tests reports with results that do not comply with Contract Documents for immediate attention. Notify the Construction Manager using acceptable means other than the test report, immediately of any test that fails to comply with the Contract Documents.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Handle and protect test specimens of products and construction materials at the Site in accordance with recognized test procedures. Provide facilities for storing, curing, and processing test specimens as required by test standards to maintain the integrity of Samples. Transport test specimens in a manner to prevent damage to specimens while in transit.

PART 2 - PRODUCTS

2.01 TESTING APPARATUS

- A. Furnish testing apparatus and related accessories necessary to perform the tests.

2.02 SAMPLE PRODUCTS

- A. Provide Samples of products in adequate quantity for testing.

PART 3 - EXECUTION

3.01 IMPLEMENTING CONTRACTOR'S QUALITY CONTROL PLAN

- A. Perform quality control observations and testing as required in each Section of the Specifications and where indicated on the Drawings.
- B. Include the following phases for each definable work task. A definable work task is one which is separate and distinct from other tasks, has separate control requirements, may be provided by different trades or disciplines, or may be work by the same trade in a different environment.
 - 1. Planning Phase: Perform the following before beginning each definable work task:
 - a. Review the Contract Documents.
 - b. Review documents the Contractor will submit and determine that they are complete in accordance with the Contract Documents.
 - c. Check to ensure that all materials and/or equipment have been tested, submitted, and approved.
 - d. Examine the work area to ensure that all required preliminary Work has been completed and complies with the Contract Documents.
 - e. Examine required materials, equipment, and sample Work to ensure that they are on hand, conform to Contract Documents, Shop Drawings and Product Data, and are properly stored.
 - f. Review requirements for quality control inspection and testing.
 - g. Discuss procedures for controlling quality of the Work. Document construction tolerances and workmanship standards for the work task.
 - h. Check that the portion of the plan for the Work to be performed incorporates document review comments.
 - i. Discuss results of planning phase with the Construction Manager. Conduct a meeting attended by the Construction Manager, Quality Control Manager, superintendent, other quality control personnel as applicable, and the foreman responsible for the work task. Instruct applicable workers as to the acceptable level of workmanship required to meet the requirements of the Contract Documents. Document the results of the planning phase actions by separate meeting minutes prepared by the Quality Control Manager and attached to the quality control report.
 - j. Do not move to the next phase unless results of investigations required for the planning phase indicate that requirements have been met.

2. Work Phase: Complete this phase after the planning phase:
 - a. Notify the Construction Manager at least 1 week in advance of beginning the Work and discuss the review of the planning phase effort to indicate that requirements have been met.
 - b. Check the Work to ensure that it is in full compliance with the Contract Documents.
 - c. Verify adequacy of controls to ensure full compliance with Contract Documents. Verify required control inspection and testing is performed.
 - d. Verify that established levels of workmanship meet acceptable workmanship standards. Compare with required Sample panels as appropriate.
 - e. Repeat the work phase for each new crew to work on-site, or any time acceptable specified quality standards are not being met.
3. Follow-Up Phase: Perform daily checks to ensure control activities, including control testing, are providing continued compliance with contract requirements:
 - a. Make checks daily and record observations in the quality control documentation.
 - b. Conduct follow-up checks and correct all defects prior to the start of additional work tasks that may be affected by the Defective Work. Do not build upon nor conceal Defective Work.
 - c. Conduct a review of the Work at least 1 month prior to the expiration of the correction period prescribed in the General Conditions with the OPT. Correct defects as noted during the review.
- C. Conduct additional planning and work phases if:
 1. The quality of on-going Work is unacceptable;
 2. Changes are made in applicable quality control staff, on-site production supervision, or crews;
 3. Work on a task is resumed after a substantial period of inactivity; or
 4. Other quality problems develop.

3.02 DEFECTIVE WORK

- A. Immediately correct any Defective Work or notify the Construction Manager why the Work is not to be corrected immediately and when corrective action will be completed.
- B. Work performed that is connected or adjacent to Defective Work or Work that would have to be removed to correct Defective Work is also considered to be Defective. Contractor is responsible for all costs associated with replacing any acceptable Work that must be removed or might be damaged by corrective actions.
- C. Document Defective Work, corrective actions taken to correct defects and that corrected Work complies with the Contract Documents.
- D. Implement countermeasures to prevent future Defective Work.

- E. No payment will be made for Defective Work. Remove Work from the Application for Payment if Work paid for on a previous Application for Payment is found to be Defective.
- F. Owner will withhold payment for Defective Work or Work that has not been tested or inspected in accordance with the CQCP, OQCP, or the Contract Documents.

3.03 VERIFICATION TESTING FOR CORRECTED DEFECTS

- A. Provide verification testing on corrected Work when corrective action is complete to demonstrate that the corrected Work complies with the Contract Documents. Conduct the same tests or inspections used to determine that the original Work was Defective. Different tests or methods may be used if approved by the OPT. Document that Defective Work has been corrected with the Construction Manager.
- B. Pay for verification testing until Work meets quality requirement set forth in the Contract Documents. OPT may perform verification testing as part of its Quality Management Program and impose a Set-off to recover the cost for this testing.

END OF SECTION

01_40_01 IBC SPECIAL INSPECTIONS

PART 1 - GENERAL

1.01 OVERVIEW

- A. The purpose of this Section is to provide the Owner and the Contractor with an understanding of what constitutes special inspections as defined by the International Building Code (IBC), Chapter 17, Special Inspections and Tests, and the Contractor's requirements per IBC and role in enabling the Owner to perform the inspections, and provide the Owner with a Statement of Special Inspection specific to this Project's Special Inspection requirements.
- B. IBC Special Inspections are not a substitute for other testing required elsewhere in the Contract Documents.
- C. IBC Special Inspections may not be performed by the Contractor, unless the Contractor and Owner are the same entity.

1.02 CONTRACTOR RESPONSIBILITIES

- A. Enable the OPT to conduct the required IBC Special Inspections as outlined below in Special Inspection Activities by the Owner.
 - 1. Set up pre-construction meeting and coordinate with OPT, prior to beginning construction, regarding the specific inspection needs and requirements that will be performed as part of these Special Inspections.
 - 2. Provide complete access to the Site and make Contract Documents available at the Site.
 - a. Provide and pay for all means necessary to enable inspection access at each location requiring inspection. This includes ladders, scaffolding, trench boxes/shielding, fall protection, adequate lighting, adequate ventilation, and designated area(s) for storing inspector equipment and test Samples. All required access must be in accordance with OSHA.
 - b. Protect Special Inspection test specimens of products and construction materials at the Site in accordance with recognized test procedures.
 - c. Provide sample materials needed to perform tests.
 - 3. Notify the Construction Manager a minimum of 2 working days in advance of when construction activities requiring testing will be performed or when construction activities will limit and/or prevent inspector(s) from observing construction Work already performed.
 - a. Provide adequate notice before proceeding with Work that would interfere with sampling, testing, or other required verification.
 - b. Notify the Construction Manager prior to the time that sampling or testing is required. Lead time is to be adequate to allow arrangements to be made for testing.
 - c. Do not proceed with any Work until tests indicate that the Work is acceptable.

- d. Notify the Construction Manager when schedules change as soon as a delay is expected.
- 4. Provide adequate quantities of representative product to be tested to the laboratory at the designated location.
- B. Submit the following documentation as Product Data in accordance with Section 01_31_13 Project Coordination:
 - 1. A schedule that establishes the approximate major and/or critical inspection Milestones. Provide a revised schedule for alterations to the schedule.
 - 2. Contractor's test and inspection log described in Paragraph 3.01 at Substantial Completion.
- C. Special Inspection activities are for the purpose of monitoring the results of the Contractor's Work to see that it is in compliance with the requirements of the Contract Documents.
- D. Special Inspection testing requirements mentioned in this Section do not release the Contractor from providing Contractor required testing specified elsewhere in the Contract Documents.
 - 1. Provide all testing documentation required by the Contract Documents.
 - 2. Pay for testing performed to verify Work performed to cure Defective Work complies with the Contract Documents.
- E. Special Inspection activities or non-performance of Special Inspection activities do not:
 - 1. Relieve the Contractor of its responsibility to perform Work and furnish materials and products and constructed Work conforming to the requirements of the Contract Documents.
 - 2. Relieve the Contractor of its responsibility for providing adequate quality control measures.
 - 3. Relieve the Contractor of its responsibility for damage to or loss of the material, product, or Work before Owner's acceptance.
 - 4. Constitute or imply Owner's acceptance.
 - 5. Affect the continuing rights of the Owner after Owner's acceptance of the completed Work.
- F. All materials and products are subject to Owner's verification testing. Material or products which have been tested or observed by Owner at a supply source or staging area may be re-observed or re-tested by Owner at any time and rejected if they do not comply with the Contract Documents.

1.03 SPECIAL INSPECTION ACTIVITIES BY THE OWNER

- A. OPT will provide registered design professionals for special inspection to meet the requirements of 2015 IBC Chapter 17, Structural Tests and Special Inspections, adopted by the City of Arlington, Texas. The registered design professional in responsible charge (RDPIRC) will coordinate and provide IBC special inspections during construction on the types of work listed below. Additionally, the OPT will employ one or more approved

agencies to perform inspections and tests during construction on the types of work listed in the Statement of Special Inspection.

B. The OPT will perform the following:

1. Permit: As required by the Building Official for permit issuance, submit the Statement of Special Inspection.
2. Preconstruction: Submit names and qualifications of each individual inspector scheduled to perform these inspections to the Building Official prior to the start of construction. Minimum requirements for inspectors must be as indicated in the Statement of Special Inspection.
3. Inspections: The RDPIRC will forward a copy of all inspection and test reports to the Building Official. Discrepancies must be brought to the immediate attention of the Contractor and Construction Manager.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION REGISTER

A. Contractor Test and Inspection Register: Include the following:

1. Date Owner was notified of impending construction Work that requires testing and/or that would interfere with subsequent inspections.
2. Name of person notified and the means of notification.
3. Date construction Work in question was completed.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain an up-to-date copy of the Contractor Test and Inspection Register at the Site and with Record Documents. Post changes and revisions as they occur. Provide access to the Contractor Test and Inspection Register for RDPIRC, OPT, and AHJ reference during normal working hours.

3.02 REPAIR AND PROTECTION

A. General:

1. On completion of inspections and tests, repair damaged construction and restore substrates and finishes.
2. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration in adjoining areas with durable seams that are invisible as possible.

B. Protect construction exposed by or for special inspection activities.

END OF SECTION

01_50_00 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide temporary facilities, including Contractor's field offices, storage sheds, workshops, and other facilities needed to complete the Work. Temporary facilities will need to support Project 1-Main Laboratory and Maintenance Building and Project 2-Mini Laboratory and Admin Building Renovation. Limited staging area will be available adjacent to the Mini Laboratory, coordinate with OPT.
- B. Provide temporary utilities needed to support the operation of the facilities and construction activities.
- C. Provide and maintain temporary project identification signs for Owner.
- D. Provide temporary informational signs to identify key elements of construction and direct the flow of traffic.
- E. Provide a weatherproof kiosk for display of permits and other notices required by Laws and Regulations.

1.02 DOCUMENTATION

- A. Submit a Shop Drawing, in accordance with Section 01_33_02 Shop Drawings, showing a scaled office floor plan prior to installation of field office. Include details for:
 - 1. Telephone equipment;
 - 2. Internet equipment;
 - 3. Computer equipment;
 - 4. Office furniture and appliances; and
 - 5. Water, sewer and power.

1.03 QUALITY ASSURANCE

- A. Inspect and test each utility before using facilities. Arrange for all required inspections and tests by regulatory agencies and obtain required certifications and permits for use of facilities.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Transport, unload, and set up all temporary buildings and utilities.

1.05 JOB CONDITIONS

- A. Locate buildings and sheds at the Site as indicated or as approved by the OPT.
- B. Prepare the Site by removing trees, brush, or debris and performing demolition or grubbing needed to clear a space adequate for the structures. See tree removal notes on the Drawings.

- C. Provide Contractor's temporary facilities and utilities in time to avoid delays in the performance of the Work.
- D. Provide and maintain temporary facilities and utilities.
- E. Operate temporary facilities in a safe and efficient manner.
 - 1. Restrict loads on utilities to operate within their designed or designated capacities.
 - 2. Provide sanitary conditions. Prevent public nuisance or hazardous conditions from developing or existing at the Site.
 - 3. Prevent freezing of pipes, flooding, or the contamination of water.
 - 4. Maintain site security and protection of the facilities.
- F. Remove temporary facilities and utilities when construction is complete, and removal is approved by the Construction Manager.

PART 2 - PRODUCTS

2.01 SIGN MATERIALS

- A. Provide wood or metal signs in sound condition, structurally adequate to withstand wind and weather and to be in conformance with City Sign requirement details or minimally as described below.
- B. Provide 3/4-inch exterior grade A/D face veneer plywood with medium density overlay for sign surface.
- C. Provide galvanized or stainless-steel bolts, brackets, fasteners, and other hardware.
- D. Provide exterior quality coatings.

2.02 CONTRACTOR'S FIELD OFFICE

- A. Furnish a field office of adequate size for Contractor's use.
- B. Subcontractors may provide their own field offices only when space is available on the Site and the OPT agrees to its size, condition, and location.

2.03 TEMPORARY STORAGE BUILDINGS

- A. Furnish storage buildings of adequate size to store any materials or equipment delivered to the Site that might be affected by weather.

2.04 TEMPORARY SANITARY FACILITIES

- A. Provide sanitary facilities at the Site for the entire duration of the Project. Maintain these facilities in a clean and sanitary condition at all times and comply with the requirements of the local health authority. On large sites, provide portable toilets at such locations so that no point at the Site will be more than 600 feet from a toilet.
- B. Use these sanitary facilities. Do not use restrooms within existing or Owner-occupied buildings.

2.05 TEMPORARY HEAT

- A. Provide heating devices needed to protect buildings during construction. Provide fuel needed to operate the heating devices and attend the heating devices at all times they are in operation, including overnight operations.

2.06 TEMPORARY UTILITIES

- A. Provide the temporary utilities for administration, construction, testing, disinfection, and startup of the Work, including electrical power, water, and telephone. Pay all costs associated with furnishing temporary utilities.
 - 1. Provide a source of temporary electrical power of adequate size for construction procedures.
 - a. Use existing power systems where spare capacity is available. Provide temporary power connections that do not adversely affect the existing power supply. Submit connections to the Construction Manager for approval prior to installation.
 - b. Provide electrical pole and service connections that comply with Laws and Regulations and the requirements of the power company.
 - 2. Provide temporary water. Potable water may be purchased from the City of Arlington.
 - 3. Provide telephone service to the Site and install telephones inside the Contractor's field offices.
- B. Provide power for construction and storage. Provide power to energize space heaters for stored electrical equipment.

2.07 WATER FOR CONSTRUCTION

- A. Provide temporary water. Potable water may be purchased from the Owner by obtaining a water meter from the Owner and transporting water from a water hydrant. Non-potable water may be used for hydraulic testing of non-potable basins or pipelines. Include the cost of water in the Contract Price.

PART 3 - EXECUTION

3.01 LOCATION OF TEMPORARY FACILITIES

- A. Locate temporary facilities in areas approved by the Construction Manager. Construct and install signs at locations approved by the Construction Manager. Install informational signs so they are clearly visible.

3.02 PROJECT IDENTIFICATION SIGNS

- A. Project signs to be in conformance with City standard sign details or minimally as described below.
- B. Arrange for a professional sign painter to paint and erect a sign for the Site in accordance with the sign information provided in the Contract Documents or provided by Owner. Sign will include identification of the OPT and Contractor (including appropriate logos, as required) and other Project information as determined by the Construction Manager. Paint

sign on a 4-foot by 8-foot by 3/4-inch exterior grade plywood board. Frame plywood with 2 x 4 wood frame and mount on not less than two 4 x 4 posts. House plywood board in a channel routed 1/2 inch deep in the 2 x 4 frame. Shoulder, glue, and screw corners.

3.03 TEMPORARY LIGHTING

- A. Provide temporary lighting inside buildings once buildings are weatherproof.
- B. Provide exterior security lighting.
- C. Provide lighting that is adequate to perform Work within any space. Temporary lights may be removed once the permanent lighting is in service.
- D. Provide portable flood lights at any time that Work will be performed outside the structure at night. Provide adequate lighting at any location Work is being performed.

3.04 DRINKING WATER

- A. Provide all field offices with potable water. Provide a dispenser and cooling apparatus if bottled drinking water is provided.
- B. Pay for water services and maintain daily.

3.05 CONSTRUCTION FENCE

- A. Install and maintain a chain-link construction fence around the Site and off-site storage yards. Fence must be a minimum 6 feet high. Provide gates with padlocks. Construction site is to be outside of plant perimeter.

3.06 REMOVAL OF TEMPORARY FACILITIES

- A. Remove temporary buildings, sheds, and utilities at the conclusion of the Project and restore the Site to original condition or finished condition in accordance with the Drawings.
- B. Remove informational signs upon completion of construction.
- C. Remove project identification signs, framing, supports, and foundations upon completion of the Project.

3.07 MAINTENANCE AND JANITORIAL SERVICE

- A. Maintain signs and supports in a neat, clean condition. Repair damage to structures, framings, or signs.
- B. Repair any damage to Work caused by placement or removal of temporary signage.

END OF SECTION

01_57_00 TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide labor, materials, equipment, and incidentals necessary to construct temporary facilities to provide and maintain control over environmental conditions at the Site. Remove temporary facilities when no longer needed.
- B. Construct temporary impounding works, channels, diversions, furnishing, and operation of pumps, installing piping and fittings, and other construction for control of conditions at the Site. Remove temporary controls at the end of the Project.

1.02 DOCUMENTATION

- A. Provide Shop Drawings in accordance with Section 01_33_02 Shop Drawings.
- B. Provide copies of notices, records, and reports required by the Contract Documents or Laws and Regulations as Product Data in accordance with Section 01_31_13 Project Coordination.

1.03 QUALITY ASSURANCE

- A. Construct and maintain temporary controls with adequate workmanship using durable materials to provide effective environmental management systems meeting the requirements of the Contract Documents and Laws and Regulations. Use materials that require minimal maintenance to prevent disruption of construction activities while providing adequate protection of the environment.
- B. Periodically inspect systems to determine that they are meeting the requirements of the Contract Documents.

1.04 POLLUTION CONTROL

- A. Prevent the contamination of soil, water, or atmosphere by the discharge of noxious substances from construction operations. Provide adequate measures to prevent the creation of noxious air-borne pollutants. Prevent dispersal of pollutants into the atmosphere. Do not dump or otherwise discharge noxious or harmful fluids into drains or sewers, nor allow noxious liquids to contaminate public waterways in any manner.
- B. Provide equipment and personnel and perform emergency measures necessary to contain any spillage.
 - 1. Contain chemicals in protective areas and do not dump on soil. Dispose of such materials at off-site locations in an acceptable manner.
 - 2. Excavate contaminated soil and dispose at an off-site location if contamination of the soil does occur. Fill resulting excavations with suitable backfill and compact to the density of the surrounding undisturbed soil.
 - 3. Provide documentation to the Owner which states the nature and strength of the contaminant, method of disposal, and the location of the disposal site.

4. Comply with Laws and Regulations regarding the disposal of pollutants.
- C. Groundwater or run-off water which has come into contact with noxious chemicals, sludge, or contaminated soil is considered contaminated. Do not allow contaminated water to enter streams or water courses, leave the Site in a non-contained form, or enter non-contaminated areas of the Site.
 1. Construct temporary holding ponds or take other precautions and measures as required to contain the contaminated water and pump to a designated storage area.
 2. Wash any equipment used for handling contaminated water or soil within contaminated areas three times with uncontaminated water prior to using such equipment in an uncontaminated area. Dispose of wash water used to wash such equipment as contaminated water.

1.05 EARTH CONTROL

- A. Remove excess soil, spoil materials, and other earth not required for backfill. Control stockpiled materials to eliminate interference with Contractor and Owner's operations.
- B. Dispose of excess earth off the Site. Provide written approval from the property owner for soils deposited on private property as Product Data per Section 01_31_13 Project Coordination. Obtain approval of the OPT if this disposal impacts the use of Site or other easements.

1.06 AIR POLLUTION CONTROL

- A. Air Pollution Watch Days:
 1. Air Pollution Watch Days (APWD) may occur in the following times:
 - a. Typical Ozone Season: May 1 through October 31.
 - b. Critical Emission Time: 6:00 a.m. to 10:00 a.m.
 2. Watch Days:
 - a. State or local environmental regulatory agencies, in coordination with the National Weather Service, may designate the following day as an APWD by 3:00 p.m. on the prior afternoon.
 - b. Begin work after 10:00 a.m. on designated APWD if work requires the use of heavy construction equipment for run times in excess of 1 hour prior to 10:00 a.m. Heavy construction equipment may be used prior to 10:00 a.m. if equipment is certified by EPA as Low Emitting or equipment burns Ultra Low Sulfur Diesel (ULSD), diesel emulsions, or alternative fuels such as CNG.
- B. Obtain air permit for construction activities per requirements of Laws and Regulations.

1.07 TEMPORARY STORMWATER POLLUTION CONTROL

- A. Provide temporary stormwater pollution control per Section 01_57_23 Temporary Stormwater Pollution Control.

1.08 MANAGEMENT OF WATER

- A. Manage water resulting from rains or ground water at the Site. Maintain trenches and excavations free of water at all times.
- B. Lower the water table in the construction area by acceptable means if necessary to maintain a dry and workable condition at all times. Provide drains, sumps, casings, well points, and other water control devices as necessary to remove excess water.
- C. Provide continuous operation of water management actions. Maintain standby equipment to provide proper and continuous operation for water management.
- D. Ensure that water drainage does not damage adjacent property. Divert water into the same natural watercourse in which its headwaters are located, or other natural stream or waterway as approved by the Owner. Assume responsibility for the discharge of water from the Site.
- E. Remove the temporary construction and restore the Site in a manner acceptable to the Construction Manager and to match surrounding material at the conclusion of the Work.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide materials that comply with Laws and Regulations.

PART 3 - EXECUTION

3.01 CONSTRUCTING, MAINTAINING, AND REMOVING TEMPORARY CONTROLS

- A. Construct temporary controls in accordance with Laws and Regulations.
- B. Maintain controls in accordance with regulatory requirements where applicable or in accordance with the requirements of the Contract Documents.
- C. Remove temporary control when no longer required, but before the Project is complete. Correct any damage or pollution that occurs as the result of removing controls while they are still required.

END OF SECTION

01_57_23 TEMPORARY STORMWATER POLLUTION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, equipment, and incidentals necessary to provide stormwater pollution prevention for the duration of the construction period including furnishing, installing, and maintaining erosion and sediment control structures and procedures and properly removing the features when no longer required.
- B. Develop, implement, and maintain a stormwater pollution prevention plan (SWPPP) in compliance with local, state, and federal Laws and Regulations. Provide preventive measures to keep sediment and other pollutants from the construction activity from entering any stormwater system, including open channels.
- C. Comply with the Texas Commission on Environmental Quality General Permit, TXR150000, (General Permit) for storm water discharges from construction activities under the Texas Pollutant Discharge Elimination System (TPDES) program.
- D. File all required legal notices and obtain required permits prior to beginning any construction activity.
- E. This Section provides guidelines and Best Management Practices information for the Contractor to use in adhering to all local, state, and federal environmental Laws and Regulations with respect to stormwater pollution prevention during construction activities.

1.02 DOCUMENTATION

- A. Documentation must be provided in accordance with Section 01_33_00 Document Management.
- B. Submit copies of required notices and reports to the Construction Manager as Product Data in accordance with Section 01_33_03 Product Data. Retain copies of these documents at the Site for review and inspection by the OPT or regulatory agencies at all times.
- C. Submit copies of required notices to local, state, and federal authorities and any other entity as required by the General Permit and applicable Laws and Regulations.
- D. Post a copy of required notices at the Site in a location where it is readily available for viewing by the general public and local, state, and federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.
- E. Maintain copies of a schedule of major construction activities, inspection reports, and revision documentation with the SWPPP required under the General Permit.
- F. Provide schedules in accordance with Paragraph 3.05.

1.03 QUALITY ASSURANCE

- A. Comply with applicable requirements of all governing authorities having jurisdiction. The Specifications and the Drawings are not intended to be prescriptive but rather to convey

the intent to provide complete slope protection, erosion control, and stormwater pollution prevention for both the Owner's property and adjacent properties.

- B. Perform Work to comply with Best Practices as established by the North Central Texas Council of Governments (NCTCOG) integrated Storm Water Management (iSWM) Design Manual for Construction.
- C. Contractor must develop and implement a SWPPP in accordance with the General Permit prior to the beginning of construction activity.
- D. Contractor assumes solely responsible for implementing, updating, and modifying the General Permit per Laws and Regulations for the SWPPP and Best Management Practices.
- E. Stormwater pollution prevention measures must be established prior to the beginning of construction and maintained during the entire length of construction until final stabilization has been achieved for the area protected.
- F. All land-disturbing activities must be planned and conducted to minimize the area to be exposed at any one time as well as time of exposure, off-site erosion, sedimentation, and adverse water quality impacts.
- G. Surface water runoff originating upgrade of an exposed area must be managed to minimize erosion and sediment loss during the period of exposure.
- H. Install measures to control both the velocity and rate of release to minimize erosion and sedimentation of the receiving water body (i.e., ditch, channel, stream) in accordance with regulatory requirements and as directed by the OPT.
- I. Periodically clean out and dispose of all sediment and other pollutants as necessary to maintain adequate treatment capacity of each pollution control feature. Clean out and properly dispose of all sediment and other stormwater pollutants at the time of completion of the Work.

1.04 JOB CONDITIONS, CODES AND ORDINANCES

- A. Comply with the local codes and ordinances. If local codes and ordinances require more stringent or additional stormwater pollution prevention measures during construction beyond those required by state and federal Laws and Regulations, the Contractor must provide such measures at no additional cost.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials used for stormwater pollution prevention must meet the minimum design and specification requirements described in the North Central Texas Council of Governments (NCTCOG) integrated Storm Water Management (iSWM) Design Manual for Construction commonly used sediment loss prevention. The Contractor must use appropriate control devices to protect against stormwater pollution from construction site activities.

- B. Erosion control blankets (ECBs) to hold seed and soil in place until vegetation is established on disturbed areas are subject to the following design criteria:
1. The type and class of erosion control mat must be specified as appropriate for the slope of the area to be protected, the flow rate (sheet flow on cut/fill slopes) or velocity (concentrated flow in swales) of stormwater runoff in contact with the ECB, and the anticipated length of service.
 2. Erosion control blankets must meet the applicable Texas Department of Transportation (TxDOT) Minimum Performance Standards for TxDOT as provided in its Erosion Control Report and/or be listed on the most current annual Approved Products List for TxDOT applicable to TxDOT Item 169 Soil Retention Blanket and its Special Provisions.
- C. Silt fences for perimeter controls located downstream of disturbed areas are subject to the following design criteria:
1. If 50 percent or less soil by weight passes the U.S. Standard sieve No. 200, select the apparent opening size (A.O.S.) to retain 85 percent of the soil.
 2. If 85 percent or more of soil by weight passes the U.S. Standard sieve No. 200, silt fences must not be used unless the soil mass is evaluated and deemed suitable by a soil scientist or geotechnical engineer concerning the erodibility of the soil mass, dispersive characteristics, and the potential grain-size characteristics of the material that is likely to be eroded.
 3. Silt fence fabric must meet the following minimum criteria:
 - a. Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 90 pounds.
 - b. Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 60 pounds.
 - c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 280 psi.
 - d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 70 (max) to No. 100 (min).
 - e. Ultraviolet Resistance, ASTM D4355. Minimum 70 percent.
 4. Filter stone for an overflow structure must be 1-1/2-inch washed stone containing no fine material. Angular shaped stone is preferable to rounded shaped stone.
 5. Fence posts must be galvanized steel or equivalent and may be T-section or L-section, 1.3 pounds per linear foot minimum, and 4 feet in length minimum. Wood posts may be used depending on anticipated length of service and provided they are 4 feet in length minimum and have a nominal cross-section of 2 inches by 4 inches for pine or 2 inches by 2 inches for hardwoods.
 6. Silt fence must be supported by galvanized steel wire fence fabric as follows:
 - a. 4-inch by 4-inch mesh size, W1.4/1.4, minimum 14-gauge wire fence fabric;
 - b. Hog wire, 12-gauge wire, small openings installed at bottom of silt fence;

- c. Standard 2-inch by 2-inch chain link fence fabric; or
 - d. Other welded or woven steel fabrics consisting of equal or smaller spacing as that listed herein and appropriate gauge wire to provide support.
- D. Inlet protection used in new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following design criteria:
 - 1. Filter fabric protection must be designed and maintained in a manner similar to a silt fence.
 - 2. Where applicable, filter fabric, posts, and wire backing must meet the material requirements specified in Paragraph 2.01.C.
 - 3. Filter gravel must be 3/4-inch washed stone containing no fines. Angular shaped stone is preferable to rounded shapes.
 - 4. Concrete blocks must be standard 8-inch by 8-inch by 16-inch concrete masonry units.
 - 5. When organic filter tubes are used, the designer must specify the type of material to be used (or excluded) on a particular site:
 - a. Straw filter material must be Certified Weed Free Forage. The straw must be in good condition, air-dried, and not rotten or moldy.
 - b. Compost must conform to the requirements for Erosion Control Compost in TxDOT Special Specification 1001 Compost (2004). Compost may provide some oil and grease removal; however, the large percentage of fines in compost will result in less filtering and more ponding of stormwater.
 - c. Wood chips must be 100 percent untreated chips and free of inorganic debris, such as plastic, glass, metal, etc. Wood chip size must not be smaller than 1 inch and must not exceed 3 inches in diameter. Shavings must not be more than 5 percent of the total mass.
 - 6. Bags used to secure inlet protection devices on pavement must be filled with aggregate, filter stone, or crushed rock that is less likely than sand to be washed into an inlet if the bag is broken. Filled bags must be 24 to 30 inches long, 16 to 18 inches wide, and 6 to 8 inches thick. Bags must be polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard and meet the following criteria:
 - a. Greater than 300 psi Mullen Burst Strength using ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - b. Greater than 70 percent UV Stability using ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus.

- E. Stone outlet sediment traps (bermed or excavated) used in situations where flows are concentrated in a drainage swale or channel are subject to the following design criteria:
 - 1. The embankment must be placed on geotextile fabric meeting the following minimum criteria:
 - a. Tensile Strength, ASTM D4632 Text Method for Grab Breaking Load and Elongation of Geotextiles, 250 pounds.
 - b. Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 135 pounds.
 - c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 420 psi.
 - d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 20 (max).
 - 2. Fill placed to constrict the swale for construction of the excavated stone outlet sediment trap and fill placed for the berm in the bermed stone outlet sediment trap must consist of clay material, minimum Plasticity Index of 30, using ASTM D4318 Standard Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 3. The embankment must be comprised of well graded stone riprap with a size range of 6 to 12 inches in diameter.
- F. Sediment basins used as treatment devices for sites with disturbed areas of 10 acres and larger that are part of a common drainage area are subject to the following design criteria:
 - 1. The embankment must be constructed with clay soil, minimum Plasticity Index of 30 using ASTM D4318 Standard Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 2. Texas Administrative Code Title 30, Chapter 299 (30 TAC 299), Dams and Reservoirs, contains specific requirements for dams that:
 - a. Have a height greater than or equal to 25 feet and a maximum storage capacity greater than or equal to 15-acre-feet;
 - b. Have a height greater than 6 feet and a maximum storage capacity greater than or equal to 50-acre-feet;
 - c. Are a high- or significant-hazard dam as defined in Chapter 299, regardless of height or maximum storage capacity; or
 - d. Are used as a pumped storage or terminal storage facility.
- G. Check dams used for long drainage swales or ditches to reduce erosive velocities are subject to the following design criteria:
 - 1. Use geotextile filter fabric under check dams exceeding 12 inches in height. The fabric must meet the material specified for the Stone Outlet Sediment Trap discussed above.
 - 2. Loose, unconfined soil, wood chips, compost, and other material that can float or be transported by runoff must not be used to construct check dams.

3. Sandbags must not be used for check dams, due to their propensity to break and release sand that is transported by the concentrated flow in the drainage swale or ditch.
4. Rock Check Dams:
 - a. Stone must be well graded with stone size ranging from 3 to 6 inches in diameter for a check dam height of 24 inches or less.
 - b. The stone size range for check dams greater than 24 inches is 4 to 8 inches in diameter.
5. Rock Bag Check Dams Bags:
 - a. Fill material should be pea gravel, filter stone or aggregate that is clean and free of deleterious material.
 - b. Bag material must comply with the requirements of Inlet Protection above.
6. Sack Gabion Check Dams:
 - a. Sack gabions must be wrapped in galvanized steel, woven wire mesh. The wire must be 20 gauge with 1-inch diameter, hexagonal openings.
 - b. Stone must be well graded with a minimum size range from 3 to 6 inches in diameter.
7. Organic Filter Tube Check Dams:
 - a. Filter material used within tubes to construct check dams must be limited to coir, straw, aspen fiber and other organic material with high cellulose content.
 - b. The material should be slow to decay or leach nutrients in standing water and comply with the requirements for Inlet Protection above.
- H. Stabilized construction exits used for sites in which significant truck traffic occurs daily are subject to the following design criteria:
 1. The construction exit material must be a minimum thickness of 6 inches. The stone or recycled concrete used must be 3 to 5 inches in size with little or no fines.
 2. The geotextile fabric must meet the following minimum criteria:
 - a. Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 300 pounds.
 - b. Puncture Strength, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 120 pounds.
 - c. Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 600 psi.
 - d. Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 40 (max).

- I. Alternative pollution prevention measures selected by the Contractor must be identified from the North Central Texas Council of Governments (NCTCOG) integrated Stormwater Management (iSWM) Design Manual for Construction.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prepare a SWPPP in accordance with applicable permit requirements for construction activity. Develop the SWPPP in conformance with the General Permit and any applicable local requirements.
- B. Prepare and implement the SWPPP prior to the beginning of construction activity in accordance with local, state, and federal Laws and Regulations.
- C. OPT may require Contractor to install stormwater pollution prevention devices and/or practices during construction in addition to those required under the approved SWPPP. Contractor must remain solely responsible for complying with all local, state, and federal Laws and Regulations.

3.02 INSTALLATION

- A. Erosion control blankets to hold seed and soil in place until vegetation is established on disturbed areas are subject to the following installation criteria:
 1. Prior to the installation of any erosion control matting, all rocks, dirt clods, stumps, roots, trash, and any other obstructions that would prevent the mat from lying in direct contact with the soil must be removed.
 2. Anchor trenching must be located along the entire perimeter of the installation area, except for small areas with less than 2 percent slope.
 3. Installation and anchoring must conform to the recommendations shown within the manufacturer's published literature for the erosion control blanket.
 4. Anchors (staples) must be a minimum of 6 inches in length and 1 inch wide. They must be made of 11-gauge wire, or equivalent, unless the ECB is intended to remain in place with final stabilization and biodegrade.
 5. Particular attention must be paid to joints and overlapping material. Overlap along the sides and at the ends of ECBs should be per the manufacturer's recommendations for site conditions and the type of ECB being installed. At a minimum, the end of each roll of ECB must overlap the next roll by 3 feet and the sides of rolls must overlap 4 inches.
 6. After installation, check blankets for uniform contact with the soil, security of the lap joints, and flushness of the staples with the ground.
- B. Silt fences for perimeter controls located downstream of disturbed areas are subject to the following installation criteria:
 1. Construct fences along a line of constant elevation (along a contour line if possible).
 2. Maximum drainage area must be 0.25 acres per 100 linear feet of silt fence.
 3. Maximum flow to any 20-foot section of silt fence must be 1 cfs.

4. Maximum distance of flow to silt fence must be 200 feet or less. If the slope exceeds 10 percent, the flow distance must be less than 50 feet.
 5. Maximum slope adjacent to the fence must be 2:1.
 6. Stone overflow structures or other outlet control devices must be installed at all low points along the fence or spaced at approximately 300 feet if there is no apparent low point.
 7. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel to prevent bypass of runoff under the fence. Fabric must overlap at abutting ends a minimum of 3 feet and must be joined such that no leakage or bypass occurs. If soil conditions prevent a minimum toe-in depth of 6 inches or installation of support post to depth of 12 inches, silt fences must not be used.
 8. Adequate room for the operation of sediment removal equipment must be provided between the silt fence and other obstructions in order to properly maintain the fence.
 9. The last 10 feet (or more) at the ends of a line of silt fence must be turned upslope to prevent bypass of stormwater. Additional upslope runs of silt fence may be needed every 200 to 400 linear feet, depending on the traverse slope along the line of silt fence.
- C. Inlet protection for new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following installation criteria:
1. Maintain barricades, signs, and safety features around the Work in accordance with all provisions of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), when installing inlet protection on publicly traveled streets or in developed areas. Ensure that inlet protection is properly designed, installed, and maintained to avoid flooding of the roadway or adjacent properties and structures.
 2. Maximum depth of flow must be 8 inches or less.
 3. A 2-inch overflow gap or weir is required on all curb inlet protection devices.
 4. Positive drainage is critical in the design of inlet protection. If overflow is not provided for at the inlet, excess flows must be routed through established swales, streets, or other watercourses to minimize damage due to flooding.
 5. Filter Fabric Protection:
 - a. Filter fabric protection is appropriate where the drainage area is less than 1 acre and the basin slope is less than 5 percent.
 - b. Filter fabric, posts, and wire mesh must meet the material requirements specified in Paragraph 2.01.
 - c. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel. This entrenchment prevents any bypass of runoff under the fence.
 - d. Stone overflow structures must be installed where flow to the inlet is concentrated and more than 1 cubic feet per second according to the criteria in Paragraph 2.01.

6. Block and Gravel Protection (Curb and Drop Inlets):
 - a. Concrete blocks are to be placed on their sides in a single row around the perimeter of the inlet, with ends abutting.
 - b. Openings in the blocks should face outward, not upward. 1/2-inch by 1/2-inch wire mesh must then be placed over the outside face of the blocks covering the holes.
 - c. Filter stone must then be piled against the wire mesh to the top of the blocks with the base of the stone being a minimum of 18 inches from the blocks.
 - d. Alternatively, where loose stone is a concern (streets, etc.), the filter stone may be placed in appropriately sized geotextile fabric bags.
7. Excavated Impoundment Protection:
 - a. Excavated impoundment protection is only applicable to drop inlets.
 - b. It should not be applied to Y inlets because it will undermine the concrete pad surrounding the inlet opening. Nor can it be used for inlets on pavement.
 - c. With this protection method, it is necessary to install weep holes to allow the impoundment to drain completely.
 - d. The impoundment must be sized such that the volume of excavation is equal to or exceeds the runoff volume from the temporary control design storm (2-year, 24-hour) for the inlet's drainage area.
 - e. The trap must have a minimum depth of 1 foot and a maximum depth of 2 feet as measured from the top of the inlet and must have side slopes of 2:1 or flatter.
8. Organic Filter Tube Protection (Curb and Drop Inlets):
 - a. Organic filter tubes may be used on paved or unpaved surfaces. On paved surfaces, tubes must be secured in place by rock bags. On unpaved surfaces, the tubes must be embedded in the ground a minimum of 3 inches and staked at 4-foot spacing.
 - b. Designer must provide calculations and specify the diameter of tube to be used based on the inlet's drainage area and the flow rate of runoff to the inlet.
 - c. The minimum allowable diameter is 12 inches.
 - d. For curb protection, the diameter of the tube must be at least 2 inches less than the height of the inlet opening. The tube should not be allowed to block the entire opening, since it will clog.
 - e. The tube must be placed on 4-inch by 4-inch or 2-inch by 4-inch wire mesh to prevent the tube from sagging into the inlet. The tube should be long enough to extend a minimum of 12 inches past the curb opening on each side of the inlet.

- D. Stone outlet sediment traps (excavated or bermed) for situations where flows are concentrated in a drainage swale or channel are subject to the following installation criteria:
1. The maximum drainage area contributing to the trap must be less than 10 acres for the excavated trap, and 5 acres or less for the bermed trap. For larger drainage areas a sediment basin must be used.
 2. The minimum storage volume must be the volume of runoff from the temporary control design storm (2-year, 24-hour) for the sediment trap's drainage area.
 3. The surface area of the design storage must be 1 percent of the area draining to the device.
 4. The maximum embankment height must be 6 feet as measured from the toe of the slope on the downstream side.
 5. Minimum width of the embankment at the top must be 2 feet.
 6. Embankment slope must be 1:5:1 or flatter.
 7. The embankment must have a depressed area to serve as the outlet with a minimum width of 4 feet.
 8. A 6-inch minimum thickness layer of 1-1/2-inch filter stone must be placed on the upstream face of the embankment when stormwater runoff contains fine silt and clay particles.
 9. The embankment must consist of stone riprap or a combination of compacted fill with stone riprap. The stone may be enclosed in wire mesh or a gabion basket and anchored to the channel bottom to prevent washing away.
 10. Fill must be placed in 8-inch loose lifts (maximum) and compacted to 95 percent Standard Proctor Density at optimum moisture content using ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 11. Geotextile fabric, covered with a layer of stone, must extend past the base of the embankment on the downstream side a minimum of 2 feet.
 12. The outlet must be designed to have a minimum freeboard of 6 inches at design flow.
- E. Sediment basins for treatment devices for sites with disturbed areas of 10 acres and larger that are part of a common drainage area are subject to the following installation criteria:
1. Design of the sediment basin should be coordinated with design of the permanent drainage infrastructure for the development. Sediment basin sizing and discharge volumes should be calculated using the NCTCOG iSWM Technical Manual.
 2. Minimum capacity of the basin must be the calculated volume of runoff from a 2-year, 24-hour duration storm event plus sediment storage capacity of at least 1000 cubic feet.
 3. The basin must be laid out such that the effective flow length to width ratio of the basin is a minimum of 4:1. The effectiveness of sediment basins may be increased by using baffles to prevent short-circuiting of flow through the basin.

4. Top width of the embankment must be determined by the Design Professional based on the total height of the embankment as measured from the toe of the slope on the downstream side.
 5. Embankment side slopes must be 3:1 or flatter.
 6. Clay soil for the embankment must be placed in 8-inch lifts and compacted to 95 percent Standard Proctor Density at optimum moisture content using ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 7. The primary outlet must have a minimum design dewatering time of 36 hours for the temporary control design storm (2-year, 24-hour).
 8. Whenever possible, the outlet must be designed to drain the basin in less than 72 hours to minimize the potential for breeding mosquitoes.
 9. The basin's primary outlet and spillway must be sized to pass the difference between the conveyance storm (25-year, 24-hour) and the temporary control design storm without causing damage to the embankment and structures.
 10. Unless infeasible, the primary outlet structure should withdraw water from the surface of the impounded water. Outlet structures that do this include surface skimmers, solid risers (non-perforated), flashboard risers, and weirs.
 11. The outlet of the outfall pipe (barrel) must be stabilized with riprap or other materials designed using the conveyance storm flow rate and velocity. Velocity dissipation measures must be used to reduce outfall velocities in excess of 5 feet per second.
 12. Risers used to discharge high flows must be equipped with an anti-vortex device and trash rack.
 13. Spillways must be constructed in undisturbed soil material (not fill) and must not be placed on the embankment that forms the basin.
- F. Check dams for long drainage swales or ditches to reduce erosive velocities are subject to the following installation criteria:
1. Typically, the dam height should be between 9 inches and 36 inches, depending on the material of which they are made. The height of the check dam must always be less than one-third the depth of the channel.
 2. Dams should be spaced such that the top of the downstream dam is at the same elevation as the toe of the upstream dam. On channel grades flatter than 0.4 percent, check dams should be placed at a distance that allows small pools to form between each check dam.
 3. The top of the side of the check dam must be a minimum of 12 inches higher than the middle of the dam. In addition, the side of the dams must be embedded a minimum of 18 inches into the side of the drainage ditch, swale, or channel to minimize the potential for flows to erode around the side of the dam.
 4. Larger flows (greater than 2-year, 24-hour design storm) must pass the check dam without causing excessive upstream flooding.

5. Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow off-site.
6. Rock Check Dams: Rock check dams must have a minimum top width of 2 feet with side slopes of 2:1 or flatter.
7. Rock Bag Check Dams:
 - a. Rock bag check dams should have a minimum top width of 16 inches.
 - b. Bag length must be 24 to 30 inches, width must be 16 to 18 inches, and thickness must be 6 to 8 inches and having a minimum weight of 40 pounds.
 - c. Minimum rock bag dam height of 12 inches would consist of one row of bags stacked on top of two rows of bag. The dam must always be one more row wide than it is high, stacked pyramid fashion.
 - d. PVC pipes may be installed through the dam to allow for controlled flow through the dam. Pipe should be schedule 40 or heavier polyvinyl chloride (PVC) having a nominal internal diameter of 2 inches.
8. Sack Gabion Check Dams:
 - a. Sack gabion check dams may be used in channels with a contributing drainage area of 5 acres or less.
 - b. Wire mesh must be one piece, wrapped around the rock, and secured to itself on the downstream side using wire ties or hog rings.
 - c. Sack gabions must be staked with 3/4-inch rebar at a maximum spacing of 3 feet. Each wire sack must have a minimum of two stakes.
9. Organic Filter Tube Check Dams:
 - a. Organic filter tubes may be used as check dams in channels with a contributing drainage area of 5 acres or less.
 - b. Organic filter tubes must be a minimum of 12 inches in diameter.
 - c. Staking of filter tubes must be at a maximum of 4-foot spacing and must alternate through the tube and on the downstream face of the tube.
- G. Stabilized construction exits for sites in which significant truck traffic occurs daily are subject to the following installation criteria:
 1. Limit site access to one route during construction, if possible; two routes for linear and larger projects.
 2. Prevent traffic from avoiding or shortcutting the full length of the construction exit by installing barriers. Barriers may consist of silt fence, construction safety fencing, or similar barriers.
 3. Design the access point(s) to be at the upslope side of the construction site. Do not place construction access at the lowest point on the construction site.
 4. Stabilized Construction Exits are to be constructed such that drainage across the entrance is directed to a controlled, stabilized outlet on-site with provisions for storage, proper filtration, and removal of wash water.

5. The exit must be sloped away from the paved surface so that stormwater is not allowed to leave the Site onto roadways.
6. Minimum width of exit must be 15 feet.
7. Vehicles must not be permitted to track or drop sediment onto paved roads, streets, or parking lots. When necessary, vehicles must be cleaned to remove sediment prior to exit onto paved areas. When washing is required, it must be done on a constructed wheel wash facility that drains into an approved sediment trap or sediment basin or other sedimentation/filtration device.
8. Minimum dimensions for the exit must be as follows:

Tract Area	Min. Width of Exit	Min. Length of Exit
<1 Acre	15 feet	20 feet
≥ 1 acre but <5 Acres	25 feet	50 feet
≥5 Acres	30 feet	50 feet

- H. Install pollution control devices in a manner consistent with their designed intent.

3.03 MAINTENANCE

- A. Always maintain pollution prevention control structures and procedures in full working order at during construction. This must include any necessary repair or replacement of items which have become damaged or ineffective. Remove sediment and other pollutants which accumulate in pollution control devices as necessary to maintain the intended design efficiency for the pollution prevention measure.
- B. Dispose properly of trash, debris, and other pollutants.
- C. Place sediment material in approved earth spoil areas or return the sediment material to the area from which it eroded.
- D. Maintain pollution prevention structures and procedures until construction is complete for the area protected and until the Site achieves final stabilization. Unless more stringently defined by local, state, or federal requirements, final stabilization is defined as achieving 70 percent of background vegetative cover or placement of permanent cover, such as concrete or asphalt.
- E. Upon completion of construction and achievement of final stabilization, properly remove the temporary pollutant control structures and complete the area as indicated. Pollution control devices made of organic materials designed to degrade naturally in place will not require removal, unless specifically required by the OPT.
- F. Erosion control blankets must be inspected regularly (at least as often as required by the General Permit) for bare spots caused by weather related events. Missing or loosened blankets must be replaced or re-anchored. Also check for excess sediment deposited from runoff. Remove sediment and/or replace blanket as necessary. In addition, determine the source of excess sediment and implement appropriate Best Management Practices to control the erosion.
- G. Silt fences must be inspected regularly (at least as often as required by the General Permit) for buildup of excess sediment, undercutting, sags, and other failures. Sediment should be removed when it reaches approximately one-half the height of the fence. In addition,

determine the source of excess sediment and implement appropriate Best Management Practices to control the erosion. If the fabric becomes damaged or clogged, it must be repaired or replaced as necessary.

- H. Inlet protection must be inspected regularly (at least as often as required by the General Permit). Floatable debris and other trash caught by the inlet protection should be removed after each storm event. Sediment should also be removed from curb inlet protection after each storm event because of the limited storage area associated with curb inlets. Sediment collected at inlet protection should be removed before it reaches half the height of the protection device. Sediment should be removed from inlets with excavated impoundment protection before the volume of the excavation is reduced by 50 percent. In addition, the weep holes should be checked and kept clear of blockage. Concrete blocks, 2-inch by 4-inch boards, stakes, and other materials used to construct inlet protection should be checked for damaged and repaired or replaced if damaged. When filter fabric or organic filter tubes are used, they should be cleaned or replaced when the material becomes clogged. For systems using filter stone, when the filter stone becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Because of the potential for inlet protection to divert runoff or cause localized flooding, remove inlet protection as soon as the drainage area contributing runoff to the inlet is stabilized. Ensure that all inlet protection devices are removed at the end of the construction.
- I. The stone outlet sediment trap should be inspected regularly (at least as often as required by the General Permit) to check for clogging of the void spaces between stones. If the filter stone appears to be clogged, such that the basin will not completely drain, then the filter stone will require maintenance. If the filter stone is not completely clogged it may be raked with a garden rake to allow the water to release from the basin. If filter stone is completely clogged with mud and sediment, then the filter stone will have to be removed and replaced. Failure to keep the filter stone material properly maintained will lead to clogging of the stone riprap embankment. When this occurs, the entire stone rip-rap structure will need to be replaced. If the aggregate appears to be silted in such that efficiency is diminished, the stone should be replaced. Trash and debris should be removed from the trap after each storm event to prevent it from plugging the rock. Deposited sediment must be removed before the storage capacity is decreased by one-third, or sediment has reached a depth of 1 foot, whichever is less. The removed sediment must be stockpiled or redistributed in areas that are protected with erosion and sediment controls.
- J. Sediment basins should be inspected regularly (at least as often as required by the General Permit) to check for damage and to ensure that obstructions are not diminishing the effectiveness of the structure. Sediment must be removed, and the basin must be re-graded to its original dimensions when the sediment storage capacity of the impoundment has been reduced by 20 percent. The removed sediment may be stockpiled or redistributed on-site in areas that are protected by erosion and sediment controls. Inspect temporary stabilization of the embankment and graded basin and the velocity dissipaters at the outlet and spillway for signs of erosion. Repair any eroded areas that are found. Install additional erosion controls if erosion is frequently evident.
- K. Check dams should be inspected regularly (at least as often as required by the General Permit). Silt must be removed when it reaches approximately one-third the height of the dam or 12 inches, whichever is less. Inspectors should monitor the edges of the dam where it meets the sides of the drainage ditch, swale, or channel for evidence of erosion due to

bypass or high flows. Eroded areas must be repaired. If erosion continues to be a problem, modifications to the check dam or additional controls are needed. Care must be used when taking out rock check dams in order to remove as much rock as possible. Loose rock can create an extreme hazard during mowing operations once the area has been stabilized.

- L. Stabilized construction exits should be inspected regularly (at least as often as required by the General Permit). The stabilized construction exit must be maintained in a condition that prevents tracking or flow of sediment onto paved surfaces. Periodic re-grading and top dressing with additional stone must be done to keep the efficiency of the exit from diminishing. The rock must be re-graded when ruts appear. Additional rock must be added when soil is showing through the rock surface. Additional controls are needed if inspections reveal a properly installed and maintained exit but tracking of soil outside the construction area is still evident. Additional controls may be daily sweeping of all soil spilled, dropped, or tracked onto public rights-of-way or the installation of a wheel cleaning system.

3.04 FIELD QUALITY CONTROL

- A. In the event of conflict between the specified requirements and stormwater pollution control laws, rules, or regulations or other local, state, or federal agencies, the more restrictive laws, rules, or regulations will apply.

3.05 SCHEDULES

- A. Prior to start of construction, submit schedules to the OPT for accomplishment of temporary and permanent erosion control work in connection with required clearing and grubbing, grading, construction, and paving. Include a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials in the submittal.

END OF SECTION

01_60_00 PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide products for this Project that comply with the requirements of this Section. Specific requirements of the detailed equipment specifications govern in the case of a conflict with the requirements of this Section.
- B. Comply with applicable specifications and standards.

1.02 DOCUMENTATION

- A. Provide documents in accordance with the Contract Documents.

1.03 QUALITY ASSURANCE

- A. Design Criteria:
 - 1. Provide products designed for structural stability and operational capability.
 - 2. Provide members designed to withstand all loads imposed by installation, erection, and operation of the product without deformation, failure, or adversely affecting the operational requirements of the product. Size and strength of materials for structural members are specified as minimums only.
 - 3. Design mechanical and electrical components for all loads, currents, stresses, and wear imposed by startup and normal operations of the equipment without deformation, failure, or adversely affecting the operation of the unit. Mechanical and electrical components specified for equipment are specified as the minimum acceptable for the equipment.
- B. Coordination:
 - 1. Provide coordination of the entire Project, including verification that structures, piping, and equipment components to be furnished and installed for this Project are compatible.
 - 2. Determine that the equipment furnished for this Project is compatible with the requirements of the Contract Documents and with the equipment and materials furnished by others.
 - 3. Provide electrical components for equipment that comply with all provisions of the Contract Documents.
 - 4. Apply protective coatings and paints to equipment in the shop that are fully compatible with the final coatings to be field applied in accordance with the Contract Documents.
- C. Adapting Substitute Products:
 - 1. The Drawings and Specifications are prepared for the specified products. Make modifications to incorporate the products into the Project if a substitution is requested

for a product is and approved in accordance with Section 01_26_00 Change Management.

2. Do not provide a product with a physical size that exceeds the available space. Consideration may be given to the acceptance of these products or equipment if the Contractor assumes all costs necessary to incorporate the item and the OPT approves such revisions.
3. Coordinate electrical requirements for the products to be installed in the Project, including revisions in electrical equipment components wiring and other elements necessary to incorporate the component.

1.04 STANDARDS

- A. The applicable industry standards referenced in the Specifications apply as if written here in their entirety.
- B. Provide equipment manufactured using structural and miscellaneous fabricated steel conforming to the standards of the American Institute of Steel Construction, unless indicated otherwise.

1.05 WARRANTIES AND GUARANTEES

- A. Correct Defective Work under the provisions of the General Conditions.
- B. Provide warranties and guarantees for periods as defined in the Contract Documents. Individual Sections of the Specifications may have more stringent warranty requirements than stated in the General Conditions. The most stringent warranty will apply in the event of conflicts within the Contract Documents.
- C. The Contract Documents may require special warranties that guarantee performance at a specified capacity, power consumption, efficiency, or other operating parameter. Correct defects that prevent products from meeting the specified performance parameters. The requirements of the special warranty that guarantee performance will be satisfied when the specified performance parameters have been met for a period of 365 days of operation unless Owner elects to accept Defective Work under the provisions of the General Conditions.
- D. The Contract Documents may require special warranties for periods extending beyond the one-year correction period specified in the General Conditions. The full warranty provisions and requirements for correction of Defective Work stated in the General Conditions apply throughout the extended warranty period.
- E. Provide a warranty bond to provide the same protection as the Contractor's performance bond for extended special warranties. The warranty bond will become effective on the day the performance bond expires which is 1 year after the date of final payment per the General Conditions. The warranty bond will remain in effect until the extended warranty period has expired.
- F. If products are repaired, modified, or replaced under the warranty bond, then the warranty period will restart on the date of completion of these repairs for a period of 6 months or until the end of the original warranty period, whichever is later. In no event will the

warranty period extend more than 6 months beyond the end of the original warranty period.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide products according to normally accepted engineering and shop practices, except where a higher standard of quality is required by the Contract Documents.
- B. Manufacture like parts of duplicate units to standard sizes and gages that are interchangeable.
- C. Two or more items of the same kind are to be identical and made by the same Supplier.
- D. Provide products suitable for the intended service.
- E. Adhere to the equipment capacities, sizes, and dimensions indicated in the Contract Documents.
- F. Do not use products for any purpose other than that for which they were designed.
- G. Provide new products. Do not provide equipment that has been in service at any time prior to delivery except for testing in accordance with the Contract Documents.
- H. Provide materials suitable for service conditions.
- I. Provide iron castings that are tough, close grained gray iron free from blowholes, flaws, or excessive shrinkage and that conform to ASTM A48, Class 30 minimum. Plugging of defective castings is not permitted. Castings must be annealed to remove internal stresses prior to machining and have the mark number and heat number cast on them.
- J. Design structural members for shock or vibratory loads.
- K. Provide steel that is at least 1/4-inch-thick for all elements that will be submerged or subject to splashing all or part of the time during normal operation of the equipment. Chamfer or grind all edges to eliminate sharp exposed edges.
- L. Make all replaceable or expendable elements such as filters, screens, drive belts, fuses, and lamps easily accessible and replaceable without need of dismantling equipment or piping. Provide standard type of all such items that are readily available from multiple suppliers.
- M. Provide stainless steel plugs for threaded openings for drains or vents in pump volutes, compressor or fan scrolls, air receivers, and heat exchangers which are plugged during normal operation.
- N. Include detailed installation instructions and a parts list for all equipment delivered to the Project site.
- O. Isolate all dissimilar metals.

2.02 EQUIPMENT APPURTENANCES

- A. Provide a safety guard covering all sides on belt or chain drives, fan blades, couplings, and other moving or rotating parts:
 - 1. Fabricate safety guards from 16 US gauge or heavier galvanized or aluminum clad sheet steel or 1/2-inch mesh galvanized expanded metal;
 - 2. Design guards for easy installation and removal;
 - 3. Provide galvanized supports and accessories for each guard;
 - 4. Provide stainless steel bolts and hardware; and
 - 5. Provide safety guards designed to prevent the entrance of rain and dripping water in outdoor locations.
- B. Provide valved taps or ports required for sampling, pressure gauges and other temporary appurtenances required for performance acceptance testing and troubleshooting.

2.03 ANCHOR BOLTS

- A. Provide suitable anchor bolts for each product.
- B. Provide anchor bolts with templates or setting drawings in time to permit casting the anchor bolts in the concrete when concrete is placed.
- C. Provide two nuts for each bolt.
- D. Provide anchor bolts for products mounted on baseplates that are long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete. Bolts must be long enough to provide full nut engagement and leave three threads exposed. Housekeeping pads are not structural concrete.
- E. Provide stainless steel anchor bolts, nuts, and washers.

2.04 SPECIAL TOOLS AND ACCESSORIES

- A. Furnish tools, instruments, lifting and handling devices, and accessories necessary for proper maintenance and adjustment that are available only from the manufacturer or are not commonly available.

2.05 EQUIPMENT IDENTIFICATION PLAQUES

- A. Provide a plaque for each piece of equipment in accordance with Section 40_05_53 Identification for Process Piping and Equipment.

2.06 LUBRICATION SYSTEMS FOR EQUIPMENT

- A. Provide equipment lubricated by systems which:
 - 1. Require attention no more frequently than weekly during continuous operation.
 - 2. Do not require attention during startup or shut down.
 - 3. Do not waste lubricants.

- B. Provide lubricants to fill lubricant reservoirs and to replace lubricant consumed during testing, startup, and operation prior to acceptance of equipment by the Owner.
- C. Provide adequate quantities of lubricants to lubricate all equipment for one year of normal service before final acceptance of the equipment will be made by the Owner.
- D. When special run-in oil or storage lubricants are used, flush out and replace with the required service lubricant.
- E. Except for rotating shaft couplings, bring all lubrication fittings to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards. Make fittings accessible from safe, permanent platforms or walk areas. Provide bull-neck, check type fittings for use with a portable high-pressure grease gun. Provide minimum 3/16-inch stainless steel tubing, securely mounted parallel to equipment lines, and protected where exposed to damage for connection from a remote fitting to the point of use.

2.07 INSULATION OF PIPING

- A. Insulate all piping on or related to equipment as required to prevent freezing under any condition. Insulate piping per the manufacturer's written instruction or per Section 23_07_19 HVAC Piping Insulation whichever is more stringent.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment including equipment pre-selected or furnished by the Owner. Assume responsibility for proper installation, startup, and making the necessary adjustments so that the equipment is placed in proper operating condition per Section 01_75_00 Starting and Adjusting.

3.02 LUBRICATION

- A. Lubricate all products provided or installed for this Project, including products furnished by the Owner, per the manufacturer's written recommendations until the product is accepted by the Owner.

END OF SECTION

01_70_00 EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Comply with requirements of the General Conditions and specified administrative procedures in closing out the Contract.

1.02 DOCUMENTATION

- A. Submit affidavits and releases on forms provided by the Construction Manager.

1.03 SUBSTANTIAL COMPLETION

- A. The following requirements must be met for the Project or a designated portion of the Work to be Substantially Complete per the General Conditions:
 - 1. Work must be fully functional and able to operate in accordance with the Contract Documents without special or extraordinary efforts on the part of the Owner.
 - 2. Performance Acceptance Testing (PAT) must be complete and indicated compliance with the requirements of the Contract Documents.
 - 3. Operation and maintenance manuals must be approved, and operator training conducted to allow the Owner to assume responsibility for operations.
- B. Conduct inspections with superintendent, Subcontractors, and Suppliers for the Work or a designated portion of the Work prior to calling for a Substantial Completion inspection by the OPT. Create a list of deficiencies in the Work that must be completed for the Project to qualify for Substantial Completion. Review the list with the Construction Manager or the designated member of the OPT. The Construction Manager or the designated member of the OPT may assist the Contractor with this effort; however, it is the Contractor's responsibility to create and manage this list of deficiencies until corrections are made.
- C. Correct the identified deficiencies prior to calling for a Substantial Completion inspection.
- D. Notify the Construction Manager that the Work or a designated portion of the Work is Substantially Complete per the General Conditions. Include a list of the items remaining to be completed or corrected before the Project will be considered for Final Completion.
- E. OPT will visit the Site to observe the Work within a reasonable time after notification is received to determine the status of the Project.
- F. Construction Manager will notify the Contractor that the Work is either Substantially Complete or that additional Work must be performed before the Project will be considered Substantially Complete.
 - 1. Construction Manager will notify the Contractor of items that must be completed before the Project will be considered Substantially Complete.
 - 2. Correct the noted deficiencies in the Work.
 - 3. Notify the Construction Manager when the items of Work in the Construction Manager's notice have been completed.

4. OPT will revisit the Site and repeat the process.
5. Construction Manager will issue a Certificate of Substantial Completion to the Contractor when the OPT considers the Project to be Substantially Complete. The certificate will include a tentative list of items to be corrected before Final Payment will be recommended.
6. Review the list and notify the Construction Manager of any objections to items on the list within 10 days after receiving the Certificate of Substantial Completion.

1.04 TRANSFER OF RESPONSIBILITIES

- A. Meet with the OPT to discuss the transfer of responsibilities for the completed facility, covering the following:
 1. Security—Determine the process for transferring responsibilities for site security from the Contractor to the Owner. Contractor will retain control of contractor entrances, however all keys, security devices, monitoring and control will be assumed by the Owner and contractor will be subject to Owner's security requirements.
 2. Utilities—Transfer utilities to the Owner when the Certificate of Substantial Completion has been issued. Submit final meter readings for utilities and similar data as of the date the Owner occupied the Work.
 3. Property Insurance—Contractor is to retain Builder's Risk Policies in effect until the Owner provides documentation that the Project has been insured by the Owner under its property insurance policies.
 4. Operations and Maintenance—Determine the extent to which Owner will assume responsibilities for full time operation and maintenance, other than to correct defects, of the facility and the schedule for making this transition. All final Operations and Maintenance manuals must be approved by the OPT and all required training must be completed.
 5. Determine if other responsibilities are to transfer between the Contractor and the Owner and develop a plan for this transition.
- B. Provide a written plan documenting the transfer of responsibilities discussed during this meeting, providing a plan of action with schedule for each area discussed.

1.05 CLOSEOUT REQUIREMENTS

- A. Provide the following before Final Completion:
 1. Record Documents per Section 01_31_13 Project Coordination;
 2. Keys and keying schedule;
 3. Warranties, bonds, and service agreements;
 4. Equipment Installation Reports;
 5. Shop Drawings, Product Data, operation and maintenance manuals, and other documentation required by the Contract Documents;
 6. Specified spare parts and special tools;

7. Certificates of occupancy, operating certificates, or other similar releases required to allow the Owner unrestricted use of the Work and access to services and utilities;
8. Evidence of continuing insurance and bond coverage as required by the Contract Documents; and
9. Final videos and photographs per Section 01_33_06 Graphic Documentation.

1.06 WARRANTIES, BONDS, AND SERVICES AGREEMENTS

- A. Provide warranties, bonds, and service agreements required by Section 01_33_00 Document Management or by the individual Sections of the Specifications.
- B. The date for the start of warranties, bonds, and service agreements is established per the General Conditions.
- C. Compile warranties, bonds, and service agreements and review these documents for compliance with the Contract Documents.
 1. Each document is to be signed by the respective Supplier or Subcontractor.
 2. Each document is to include:
 - a. The product or Work item description;
 - b. The firm name, with the name of the principal, address, and telephone number;
 - c. Scope of warranty, bond, or services agreement;
 - d. Date, duration, and expiration date for each warranty bond and service agreement;
 - e. Procedures to be followed in the event of a failure; and
 - f. Specific instances that might invalidate the warranty or bond.
- D. Submit digital copies of the documents to the Construction Manager for review.
- E. Submit warranties, bonds, and services agreements within 10 days after equipment or components placed in service.

1.07 FINAL COMPLETION

- A. Conduct inspections with Superintendent, Subcontractors, and Suppliers prior to calling for a Final Completion inspection by the OPT. Create a list of deficiencies in the Work that must be completed for the Project to qualify for the Final Completion inspection. Review the list with the Construction Manager or the designated member of the OPT. The Construction Manager or the designated member of the OPT may assist the Contractor with this effort; however, it is the Contractor's responsibility to create and manage this list of deficiencies until corrections are made.
- B. Identify, list, and correct deficiencies prior to calling for a Final Completion inspection. The Project at the call for Final Completion represents the Contractor's interpretation of a project completed in conformance with the Contract Documents and reflects the Contractor's representation of a quality project meeting the Owner's expectations.

- C. Notify the Construction Manager when:
 - 1. Work has been completed and complies with the Contract Documents;
 - 2. Equipment and systems have been tested per the Contract Documents and are fully operational;
 - 3. Final operation and maintenance manuals have been provided to the Owner and all operator training has been completed;
 - 4. Specified spare parts and special tools have been provided;
 - 5. Work is complete and ready for final inspection;
 - 6. Final documentation for all outstanding Modifications and Claims (other than those listed on the Certificate of Final Completion) have been processed and are ready for incorporation into the final Application for Payment; and
 - 7. Closeout requirements in Paragraph 1.05 have been completed.
- D. OPT will visit the Site to determine if the Project is complete and ready for final payment within a reasonable time after the notice is received.
- E. Construction Manager will notify the Contractor that the Project is complete or will notify the Contractor that Work is Defective.
- F. Take immediate steps to correct Defective Work. Notify the Construction Manager when Defective Work has corrected. OPT will visit the Site to determine if the Project is complete and the Work is acceptable. Construction Manager will issue a Certificate of Final Completion to the Contractor when the Project is complete or will notify the Contractor that Work is Defective.
- G. Submit the request for final payment with closeout documentation described in Paragraph 1.06 if notified that the Project is complete, and the Work is acceptable.

1.08 REINSPECTION FEES

- A. Owner may impose a set-off against the Application for Payment in accordance with the General Conditions to compensate the OPT for additional visits to the Project if additional Work is required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01_74_23 FINAL CLEANING

PART 1 - GENERAL

1.01 SUMMARY

- A. Perform a thorough cleaning of the Site, buildings, or other structures prior to Owner occupancy of the buildings, and prior to Final Completion. Leave the Project clean and ready for occupancy.

1.02 DOCUMENTATION

- A. Provide data for maintenance per Section 01_33_04 Operation and Maintenance Data.

1.03 QUALITY CONTROL

- A. Use experienced workmen or professional cleaners for final cleaning.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnish the labor and products needed for cleaning and finishing as recommended by the manufacturer of the surface material being cleaned.
- B. Use cleaning products only on the surfaces recommended by the Supplier.
- C. Use only those cleaning products which will not create hazards to health or property, and which will not damage surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

- A. Thoroughly clean the entire Site and make ready for occupancy.
 - 1. Remove construction debris, boxes, and trash from the Site.
 - 2. Remove construction storage sheds and field offices.
 - 3. Restore grade to match surrounding condition and remove excess dirt.
 - 4. Sweep all drives and parking lots clean of dirt and debris. Use water trucks or hose down paved site to like new appearance.
- B. Clean floors and inspect for damage.
 - 1. Remove oil, grease, paint drippings, and other contaminants from floors, then mop repeatedly until thoroughly clean. Replace damaged flooring.
 - 2. Clean resilient flooring with an approved cleaner and provide one coat of liquid floor polish as recommended by the flooring manufacturer. Polish to a buffed appearance with powered floor buffer.
 - 3. Vacuum all carpets with powered floor sweeper to remove dirt and dust. Remove glue or other substances from nap of carpet.

- C. Clean and polish inside and outside glass surfaces. Wash with window cleaner and water, apply a coat of high-quality glass polish, and wipe clean. Do not scratch or otherwise mar glass surfaces.
- D. Clean wall surfaces to remove dirt or scuff marks. Remove excess adhesive along top edges of wall base. Remove adhesive from surfaces of vinyl wall coverings.
- E. Align ceiling tile to fit properly in grid and replace cracked or damaged tile. Remove smear marks and other dirt from tile and clean surface of grid system.
- F. Spot paint nicks and other damage. Repaint the wall from inside corner to inside corner if spot-painting does not blend into the existing color and texture of the surrounding surfaces. Touch up damaged surfaces on factory finished equipment using special paint furnished by the manufacturer.
- G. Clean plumbing fixtures, valves, and trim. Clean toilet seats and covers. Remove labels and adhesive from fixtures. Remove floor drains and clean baskets or buckets. Polish strainers and exposed chrome or brass.
- H. Remove dirt, oil, grease, dust, and other contaminants from floors, equipment, and apparatus in mechanical and electrical rooms.
- I. Clean and polish ceramic tile floors and wall surfaces to remove mildew or other stains. Tuck point defective joints.
- J. Inspect exterior painted surfaces. Spot paint any damaged surfaces.
- K. Clean permanent filters and replace disposable filters on heating, ventilating, and air conditioning systems. Clean ducts, blowers, and coils if units were operated without filters during construction.
- L. Clean roof areas of debris; flush roof drainage systems with water until clear.
- M. Broom clean exterior paved surfaces and rake clean other surfaces of the grounds.
- N. Clean and polish all electrical equipment and exposed conduits. Remove paint overspray. Provide a blemish free appearance on all exposed equipment and conduits.

END OF SECTION

01_75_00 STARTING AND ADJUSTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide step-by-step procedures for starting provided systems, including equipment, pumps, and processes.
- B. Provide pre-startup inspections by equipment manufacturers.
- C. Place each system in service and operate the system to prove performance and to provide for initial correction of defects in workmanship, calibration, and operation.
- D. Provide for initial maintenance and operation.
- E. Include costs for starting and adjusting provided by manufacturer's representative in the Cost of Work for the equipment package.
- F. Owner will provide chemicals, if any, required for continued operations.
- G. Starting and Adjusting includes requirements of Section 01_75_17 Commissioning.
- H. Provide adequate chemicals and supplies for all chemical systems to provide for startup testing and initial operations through performance acceptance testing.

1.02 STANDARDS

- A. Comply with the specified standards associated with the testing or startup of equipment.

1.03 DOCUMENTATION

- A. Provide the following documents in accordance with Section 01_33_00 Document Management:
 - 1. A Plan of Action for testing, checking, and starting equipment as Product Data per Section 01_31_13 Project Coordination.
 - 2. Equipment Installation Reports on the form provided by the Construction Manager certifying that the equipment and related appurtenances have been thoroughly examined and approved for startup and operation.
 - 3. Operation and maintenance manuals per Section 01_33_04 Operation and Maintenance Data. Preliminary operation and maintenance data must be approved before installation, testing, and initial operation of equipment or providing training required by Section 01_79_00 Training of Operation and Maintenance Personnel.

1.04 SPECIAL JOB CONDITIONS

- A. Do not start or test any equipment until the complete unit has been installed and thoroughly checked.
- B. Provide the services of a qualified representative of the manufacturer to attend the tests and startup procedures as required by this Section.

- C. Do not start or test any equipment until the preliminary operation and maintenance manual per Section 01_33_04 Operation and Maintenance Data has been approved.

PART 2 - PRODUCTS

2.01 TESTING INSTRUMENTATION

- A. Provide new instrumentation and testing devices needed to conduct tests for maintenance and operation as recommended in the operation and maintenance manuals. This equipment is to become the property of the Owner and transferred in good working order as a spare part at Substantial Completion. This equipment is to be calibrated and ready for use during the startup procedure and for training provided in accordance with Section 01_79_00 Training of Operation and Maintenance Personnel.

PART 3 - EXECUTION

3.01 SERVICES OF MANUFACTURER'S REPRESENTATIVES

- A. Provide the services of experienced and technically competent representatives of the manufacturer for inspections, tests, supervision of installation, training, and assistance with placing equipment in operation.
- B. Perform installation, adjustment, and testing of the equipment under the direct supervision of the manufacturer's representative where specified. Certify that the equipment and related appurtenances have been thoroughly examined and approved for startup and operation in the Equipment Installation Reports.
- C. Provide on-site services as necessary for proper and trouble free operation of the equipment.

3.02 INSPECTION AND STARTUP

- A. Inspect equipment prior to placing any equipment or system into operation. Make adjustments as necessary for proper operation. Do not start or test any apparatus until the complete unit has been installed and thoroughly checked.
 - 1. Check for adequate and proper lubrication.
 - 2. Determine that parts or components are free from undue stress from structural members, piping, or anchorage.
 - 3. Adjust equipment for proper balance and operations.
 - 4. Determine that vibrations are within acceptable limits.
 - 5. Determine that equipment operates properly under full load conditions.
 - 6. Determine that the equipment is in true alignment.
 - 7. Ensure that the proper procedure is employed in startup of systems.

3.03 STARTING REQUIREMENTS

- A. Refer to the individual Specification Sections for specific startup procedures or other requirements.

3.04 INITIAL OPERATION

- A. Start, test, and place equipment and systems into operation for 30 days to allow the OPT to observe the operation and overall performance of the equipment and to determine that controls function as intended.
- B. Operate equipment which is used on a limited or part-time basis in the presence of the OPT for a period long enough to demonstrate that controls function as specified.
- C. Perform acceptance test as specified in individual Specification Sections. Demonstrate that equipment and systems meet the specified performance criteria.
- D. Equipment and systems may be considered as substantially complete at the end of this initial operation period if the equipment is placed in continuous beneficial use by the Owner, unless specifically stated otherwise in the individual equipment Specifications.

3.05 INITIAL MAINTENANCE

- A. Maintain equipment in accordance with the operation and maintenance manuals until Project is substantially complete and provisions have been made by the Owner for accepting responsibility for equipment operation in accordance with the General Conditions.
- B. Service equipment in accordance with the operation and maintenance manuals immediately before releasing the equipment to the Owner.

END OF SECTION

01_79_00 TRAINING OF OPERATION AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide services of Supplier's operation and maintenance training specialists to instruct Owner's personnel in recommended operation and maintenance procedures for equipment furnished. Details for training may be established in the specifications for that equipment.
- B. Provide a combination of classroom and hands on training.
- C. Training may be conducted at Contractor's or Supplier's facilities provided Contractor pays for travel, lodging, and per diem costs of the Owner.
- D. Record training sessions on video and submit to the Owner on DVD disk in MPEG-4 format for Owner's later use in instructing Owner's personnel. Include this recording as part of the final operation and maintenance manual. Provide legal releases or pay additional fees required to allow training by the manufacturer to be recorded.
- E. Include the cost for training and startup in the Cost of the Work for each equipment package.

1.02 DOCUMENTATION

- A. Provide documentation in accordance with Section 01_33_00 Document Management and include:
 - 1. Equipment Installation Reports in accordance with Section 01_75_00 Starting and Adjusting on forms provided by the Construction Manager;
 - 2. A lesson plan for training in accordance with Paragraph 3.01.C;
 - 3. Credentials of Supplier's proposed operation and maintenance instructors demonstrating compliance with requirements of Paragraph 1.04; and
 - 4. Operation and maintenance manuals per Section 01_33_04 Operation and Maintenance Data. Preliminary operation and maintenance data must be approved before installation, testing, and initial operation of equipment or providing training required by the Section.

1.03 SCHEDULING OF TRAINING

- A. Coordinate training services with startup and initial operation of equipment on days and times Owner is available.
- B. Training may be required outside of normal business hours to accommodate schedules of operation and maintenance personnel.
- C. Provide training of Owner's personnel after acceptable preliminary operation and maintenance manuals have been approved.
- D. Coordinate training with equipment startup and testing and availability of Owner's personnel.

- E. Provide a proposed training schedule for review and acceptance by OPT showing all training required in the Contract Documents. Demonstrate compliance with specified training requirements relative to number of hours of training, number of training sessions, and scheduling.
- F. Submit initial training schedule at least 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with OPT's comments, no later than 30 days prior to starting the first training session.
- G. Owner reserves the right to modify personnel availability for training in accordance with process or emergency needs.
- H. Schedule for training is to be approved by Owner.
 - 1. Schedule training and startup operations for no more than one piece of equipment or system at a time.
 - 2. Owner may require re-scheduling of training if operations personnel are not available for training on a scheduled date.
 - 3. Provide a minimum of 2 weeks' notice if training must be rescheduled.
 - 4. Training is to be limited to 24 hours per week.
 - 5. Time required for training is to be included in the development of the Project schedule.
- I. Schedule and coordinate training for equipment or systems which depend upon other equipment or systems for proper operation so that trainees can be made familiar with the operation and maintenance of the entire operating system.

1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. Manufacturer's instructors must be factory-trained by the equipment manufacturer.
- B. Instructors must have knowledge of the theory of operation and practical experience with the equipment or system.
- C. Instructors must be proficient and experienced in conducting training of the type required and must have successfully conducted similar training courses.
- D. Qualifications of instructors are subject to acceptance by OPT. Provide services of replacement instructor with acceptable qualifications if OPT does not accept qualifications of proposed instructor. Include each instructor's résumé and specific details of instructor's operating, maintenance, and training experience relative to the specific equipment for which instructor will provide training to demonstrate their qualifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 OPERATOR TRAINING

- A. Provide classroom and hands-on training of the care and operation of the equipment to the Owner's personnel.

- B. Provide training in adequate detail to ensure that the trainees who complete the program will be qualified and capable of operating and maintaining the equipment, products, and systems provided.
- C. Provide a training plan that indicates the schedule and sequence of the training programs. The training plan is to include for each course:
 - 1. Number of hours for the course;
 - 2. Agenda and narrative description, including the defined objectives for each lesson;
 - 3. Draft copy of training handbooks;
 - 4. A descriptive listing of suggested reference publications;
 - 5. Audio-visual equipment required for training; and
 - 6. Type and number of tools or test equipment required for each training session.
- D. Provide and use training aids to complement the instruction and enhance learning.
 - 1. Provide training handbooks for use in both the classroom and the hands-on phases of training for each course.
 - 2. Instructional materials must include references to the operation and maintenance manuals and identify and explain the use of the manual.
 - 3. Provide a copy of all audio/visual training materials used in the presentations to the Owner.
- E. Operations training is to include:
 - 1. Orientation to provide an overview of system/subsystem configuration and operation;
 - 2. Terminology, nomenclature, and display symbols;
 - 3. Operations theory;
 - 4. Equipment appearance, functions, concepts, and operation;
 - 5. Operating modes, practices, and procedures under normal, diminished, and emergency conditions;
 - 6. Startup and shutdown procedures;
 - 7. Safety precautions;
 - 8. On-the-job operating experience for monitoring functions, supervisory, or command activities. Include functions and activities associated with diminished operating modes, failure recognition, and responses to system/subsystem and recovery procedures; and
 - 9. Content and use of operation and maintenance manuals and related reference materials.
- F. Provide training for performing on-site routine, preventive, and remedial maintenance of the equipment or system. Maintenance training is to include:
 - 1. Orientation to provide an overview of system/subsystem concept, configuration, and operation;
 - 2. Operations theory and interfaces;

3. Instructions necessary to ensure a basic theoretical and practical understanding of equipment appearance, layout, and functions;
 4. Safety precautions;
 5. Use of standard and special tools and test equipment;
 6. Adjustment, calibration, and use of related test equipment;
 7. Detailed preventive maintenance activities;
 8. Troubleshooting, diagnostics, and testing;
 9. Equipment assembly and disassembly;
 10. Repair and parts replacement;
 11. Parts ordering practices and storage;
 12. Failure and recovery procedures;
 13. Cabling and/or interface connectors;
 14. Content and use of operation and maintenance manuals and related reference materials;
 15. Procedures for warranty repairs;
 16. Lubrication; and
 17. Procedures, practices, documentation, and materials required to commence system maintenance.
- G. Provide training for the equipment listed in the technical specification.

END OF SECTION

SECTION 02 23 10

FENCE SLIDING GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions.
- B. Related Work Specified Elsewhere:
 - 1. Section 02 28 21 CHAIN LINK FENCES

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Galvanized Steel Modular Cantilever Gate System complete with related hardware, posts, rails, and accessories necessary for a structurally integrated and aesthetically balanced installation, with steel fabric No. 9 gage, 2-inch steel diamond-mesh, chain link infill panel as specified in Section 02 28 21 – Chain Link Fences.
 - 2. Concrete foundation for posts.

1.3 REFERENCES

- A. American Society for Testing and Materials ASTM, © ASTM International:
 - 1. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 2. ASTM A525 Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
 - 3. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 4. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - 5. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 6. ASTM C33 Standard Specification for Concrete Aggregates
 - 7. ASTM C150 Standard Specification for Portland cement
 - 8. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
- B. American Concrete Institute ACI, © American Concrete Institute:
 - 1. ACI 301 Specifications for Structural Concrete
- C. National Fire Protection Association NFPA National Electric Code, © NFPA
 - 1. NEC 250.194 Grounding and Bonding of Fences and Other Metal Structures

1.4 SYSTEM DESCRIPTION

- A. The Manufacturer shall supply a Galvanized Steel Modular Cantilever Gate System complete with all hardware, posts and accessories necessary for a structurally integrated and aesthetically balanced installation. Note: Galvanized Steel Modular Cantilever Gate

System shall include necessary provisions for installation of customer-specified infill material, as specified in Section 02 28 21, Chain Link Fences.

- B. Design Requirements: Galvanized Steel Modular Cantilever Gate System, foundation and installation shall be designed by a Registered Professional Engineer (PE) to withstand minimum [90] mph wind load. (Where applicable, wind load rating to be based on IBC 2003 or local code if more stringent.)

1.5 SUBMITTALS

- A. Product Data: For each product indicated, include manufacturer's product literature, shop drawings, and product performance data indicating compliance with this specification.
- B. Installation Drawings: Show layout, locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, post sizes and spacing, gate details/dimensions, details of post anchorage, post attachment/bracing and any optional security components as may be requested by the specifier.

1.6 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and the materials and techniques specified. Review and follow manufacturer's installation instructions.
- B. Provide Galvanized Steel Modular Cantilever Gate System and associated components as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of 10 years documented experience.
- D. Field Quality Control to be conducted by (Owner's Project Manager) (General Contractor) (Manufacturers Technical Specialist).

1.7 DELIVERY, HANDLING AND STORAGE

- A. Deliver gate and associated components to project site, completely pre-finished. Upon receipt at the job site, all materials and components shall be checked to verify receipt of all required materials, and to ensure that no damages occurred during shipping. Materials shall be handled and stored properly to protect against damage and theft.
- B. Handle gate and associated components to protect finish from any scuffs, abrasion or other damage during unloading, storage and installation. Excessive damage to visible surfaces will be cause for rejection.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Bases of design Manufacturer: BASTEEL Perimeter Systems, Frankfort IN 46041, USA, Fax: 765-654-8755; Office Phone 765-654-5525; Toll Free 866-369-8335; www.basteel.com; info@basteel.com

1. BASTEEL Galvanized Steel Modular Cantilever Gate System.

2.2 MATERIAL

- A. Galvanized Steel Modular Cantilever Gate System is to conform to performance and design requirements specified herein. Gate System shall be manufactured from the following materials:
 1. Gates: Design of gates shall be as shown on the Drawings.
 - a. Gate frame: Material of construction shall be ASTM A500 mechanical tubing, zinc coated in accordance with ASTM F1043 type B. Gate frame shall include mounting provisions for infill panels as supplied by others. Suitable infill panels to be installed prior to use.
 - b. Frame members: Material of construction shall be ASTM A500 mechanical tubing, zinc coated in accordance with ASTM F1043 type B. Lower frame member shall be stitch welded to galvanized steel track as required to meet structural loads. Fabrication process shall utilize MIG welding method with silicon-bronze welding wire conforming to AWS A5.7/ER CUSI-A as to inhibit corrosion. Gate frame to be designed and fabricated to be structurally rigid without the use of truss rods or cables to ensure frame squareness.
 2. Gate track: Material of construction shall be A36 steel weighing not less than 14.46 lbs. per linear foot, with minimum yield strength 36,000 PSI. Track to be hot-dip galvanized per ASTM A123 prior to fabrication.
 - a. Gate track shall be designed for use with a minimum of two 8-wheel mono-block carriage assemblies utilizing heavy-duty maintenance-free pre-lubricated noiseless ball bearings shielded to protect against normal ambient environmental conditions such as wind, dust, dirt, damp, rain, snow and/or icing conditions.
 3. Installation Template: Laser cut installation template shall be provided to aid in installation and ensure that trolley carriages are installed in line to prevent binding and ensure smooth operation
 4. Gate posts: Material of construction shall be steel as required to meet structural loads.
 - a. Post detail: Material of construction shall utilize hot dip galvanized corrosion coating in accordance with ASTM A123. Post Caps shall be of press on type steel caps zinc plated to ASTM B633, Service Class II, or, malleable steel caps galvanized to ASTM A123.
 5. Security components: Gate System shall be designed to incorporate security components such as barb arms, barbed wire.
 6. Other components: Material of construction shall use galvanized coating corrosion protection.
 7. Foundation: Size and overall design to be as determined by Registered Professional Engineer (PE) based on gate size, local wind loading requirements and installation type.

2.3 FACTORY FINISH

- A. Gates shall be natural galvanized finish.

2.4 CONCRETE FOOTINGS

- A. General: Comply with ACI 301 for cast-in-place concrete; materials consisting of Portland cement complying with ASTM C150, aggregates complying with ASTM C33, and potable water.

- B. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate, or as specified by Registered Professional Engineer (PE).
- C. Footings: 2.4.3.1 Footings shall be minimum 3,000 psi after twenty-eight (28) days concrete. Footing sizes and overall design shall be determined by Registered Professional Engineer (PE).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and verify areas to receive gate system and associated components.
- B. Coordinate gate installation with other related work.
- C. Examine conditions under which gates are to be installed. Notify Contractor of unsatisfactory conditions. Do not proceed with work until conditions are satisfactory to the installer.

3.2 INSTALLATION

- A. Install gate in accordance with manufacturer's instructions and approved installation drawings.
- B. Handle gate components to protect finish coating from any scuffs, abrasion or other damage during installation. Excessive damage to visible surfaces will be cause for rejection.
- C. Space posts at dimensions indicated in the installation drawings.
- D. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and at correct height and spacing, and stabilized in position during placement and finishing operations until concrete is sufficiently cured. Prior to concrete placement, protect portion of posts above ground from concrete splatter.
- E. Install gate level, plumb, and secure for full opening without interference. Attach hardware provided by gate manufacturer. Install ground-set items in concrete for anchorage.
- F. Avoid unnecessary cutting or drilling of factory-furnished gate components.

3.3 SYSTEM VALIDATION

- A. After installation is accomplished, adjust gate to operate smoothly, easily, and quietly throughout entire operational range. Confirm gate remains in a balanced and stationary position without unintended movement while positioned at various locations within the gate operating range, including both extremes of travel. Confirm latches and locks engage and release accurately and securely without forcing or binding.
- B. The Gate System shall be operated for a sufficient period of time to demonstrate that the system was properly installed and is in proper working order.

3.4 CLEANING

- A. Installation contractor shall remove packing materials and unused product, and level uneven areas that may result from gate installation.

END OF SECTION

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SECTION 02 28 21

CHAIN LINK FENCES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes chain link fabric fence, chain link fence gate infill and related components for security fence.
- B. Related Work Specified Elsewhere:
 - 1. Division 3 – CONCRETE
 - 2. 03 23 10 FENCE GATES

1.2 REFERENCES

- A. Applicable Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - a. A 123: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
 - b. A 153: Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - c. A 392: Zinc-Coated Steel Chain Link Fence Fabric
 - d. F 669: Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence
 - e. F 1083: Pipe, Steel, Hot Dipped, Zinc-Coated (Galvanized) Welded, for Fence Structures

1.3 SUBMITTALS

- A. Submit as specified in DIVISION 1 – GENERAL REQUIREMENTS.
- B. Includes, but not limited to, the following:
 - 1. Product Data: Manufacturer's technical data, specifications and installation instructions for fence and gate posts, fabric, gates and accessories.
 - 2. Shop Drawings: Showing layout, location of fence gates, posts and including details illustrating fence height, sizes of posts, rails, braces, gates, hardware list and accessories.
 - 3. Mill certification that materials meet specifications of member size, strength, wall thickness, and coatings.

1.4 QUALITY ASSURANCE

- A. Provide chain link fences and gates as complete units, including necessary erection accessories, fittings and fastenings, from a single source or manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following:
 - 1. Galvanized Steel Fencing and Fabric:
 - a. Allied Tube and Conduit Corp.
 - b. Anchor Fence, Inc.

2.2 GENERAL

- A. Fence height and gate width(s) shall be as indicated on Drawings.
- B. Dimensions indicated for pipe, roll-formed, and H-sections are outside dimensions, exclusive of coatings.

2.3 FABRIC

- A. Steel Fabric:
 - 1. No. 9 gage, 2-inch diamond-mesh steel, chain link fabric. Furnish 1-piece fabric widths for fencing up to 6'-0" high.
 - 2. Galvanized: Conform to ASTM A 392 with zinc coating, Class 2, 2.0 ounces minimum per square foot of wire surface.
 - 3. Bottom selvage knuckled and top selvage twisted for fabric over 5'-0".

2.4 FRAMING AND ACCESSORIES

- A. Steel Framework:
 - 1. General: Galvanized steel, ASTM F 1083 or ASTM A 123, with not less than 1.8-ounce zinc per square foot of surface, or steel conforming to ASTM A 569 externally triple-coated with hot-dip galvanizing at 1.0 ounce/square foot, chromatic conversion coatings and clear acrylic polyurethane and coted internally with zinc-rich coating.
 - 2. Fittings and Accessories: Galvanized, ASTM A 153, with zinc weights per Table 1.

2.5 STEEL POSTS, TENSION WIRE AND BRACES

- A. Minimum size and weight of steel components shall be as follows:
 - 1. Posts for Fabric Height over 6 feet:
 - a. End, Angle, Corner or Pull Posts: 2.875 inches od at 5.79 pounds per foot.
 - b. Line Posts: 6-foot Height: 2.37 inches
 - 2. Tension Wire: No. 7 gage coiled spring wire, metal and finish to match fabric. Locate at bottom and top of fabric.
 - 3. Wire Tires: 11-gage galvanized steel to match fabric core material.

2.6 BARBED WIRE AND SUPPORTING ARMS (PERIMETER SECURITY FENCE ONLY)

- A. Supporting Arms:
 - 1. One for each post.
 - 2. Single arm at 45° with vertical, sloping to parking lot side of fence.
 - 3. Constructed for attaching three rows of barbed wire to each arm and designed as a weathertight closure cap where tubular posts are used.
 - 4. Designed for 250-pound minimum pull-down load.
 - 5. Attached to steel posts or integral with post top.
 - 6. Malleable iron or pressed steel.
- B. Barbed Wire:
 - 1. Two-strand, 12-1/2 gage steel wire with 14-gage, 4-point barbs 3 inches o.c.
 - 2. Metal and finish to match fabric.
 - 3. Three rows required.

2.7 CONCRETE

- A. 4,000 psi concrete in accordance with DIVISION 3 for structural concrete.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Grading: Perform final grading prior to installation of fence.
- B. Placing Crushed Rock:
 - 1. Place prior to installing fabric.
 - 2. Place to a depth of 6 inches below grade and 2- foot width, centered along post lines.

3.2 INSTALLATION

- A. Fence:
 - 1. Follow general contour of ground and properly align. Install as indicated.
 - 2. Posts:
 - a. Set in concrete bases or core drill into existing pavements. Trowel-finish tops of footings and dome to direct water away from posts.
 - b. Install plumb and in straight alignment.
 - c. Space 10 feet center-to-center maximum.
 - d. Install pull posts every 300 feet if no corner posts are encountered in that distance.
 - e. Install corner posts at changes in direction of 30° or more.
 - f. Install pull posts at change in direction of 10° to 30°.
 - g. Install and pull posts at all abrupt changes in grade.
 - 3. Post Bracing:
 - a. Install at each end, pull and gate post, and each side of each corner post.
 - b. Install so posts are plumb when diagonal rod is under tension.

4. Tension Wire: Weave through the fabric and tie to each post with minimum 6 gauge galvanized wire to match fabric finish.
 5. Fabric:
 - a. Stretch taut with equal tension on each side of line posts.
 - b. Install fabric on unsecure (outside) side of fence posts and anchor to framework so that fabric remains in tension after pulling force is released.
 - c. Use U-shaped, wire, conforming to diameter of pipe to which attached, clasp pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.
 - d. Fasten fabric to steel posts with wire ties spaced 12 inches o.c. maximum.
 - e. Fasten fabric to tension wire using 11-gage hog rings of same material and finish as fabric wire, spaced at 24 inches o.c.
 6. Stretcher Bars:
 - a. Thread through or clamp to fabric 4 inches o.c.
 - b. Secure to posts with metal bands spaced 15 inches o.c. maximum.
 - c. Install at each gage, pull and end post, and each side of corner post.
 7. Post Tops and Barbed Wire Supporting Arms: Install on each post (for perimeter security fences).
 8. Barbed Wire (for Perimeter Security Fences):
 - a. Attach three rows to each barbed wire supporting arm. Pull wire taut and fasten securely to each arm.
 - b. Install three rows above fabric and on extended gate end members of swing gates.
 9. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- B. Repairing Damaged Coatings:
1. Repair any damaged coatings in the shop or field by recoating with compatible and similar coating.
 2. Apply per manufacturer's recommendations.

END OF SECTION

SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
 2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
 3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
 4. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
 - a. Part 61—National Emission Standards for Hazardous Air Pollutants.
 - b. Part 82—Protection of Stratospheric Ozone.
 - c. Part 273—Standards for Universal Waste Management.

1.2 DEFINITIONS

- A. ACM: Asbestos-containing material.
- B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof, or of any piping (exposed or buried) or equipment system.
- C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.
- D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.
- E. Renovation: Altering a facility or one or more facility components in any way.
- F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.
- G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.
- H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have

been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.3 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. The Texas Department of Health (department) shall be notified on a form specified by the department of any asbestos abatement activity, renovation or operations and maintenance (O&M) activity affecting asbestos-containing building materials (ACBM), or any demolition in facilities or public buildings. Notification shall be made to the department no less than ten working days (not calendar days) prior to commencement of the activity and shall be submitted on the form specified by the department. It is a requirement that the department notification form be filled out completely and properly.

1.4 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation;
2. The Contractor's planned sequence of operations, including coordination with existing operations in progress;
3. Procedures for removal and disposition of materials specified to be salvaged or relocated.
4. Disconnection schedule of utility services.
5. Detailed description of any existing equipment that is not scheduled for demolition but will or may be impacted by the demolition and how the Contractor plans to address.
 - a. The Contractor shall take care when disconnecting and removing equipment or materials which are to be reinstalled. Equipment shall be stored in a manner so as to prevent damage and provide protection from the elements. Equipment stored outside shall be properly covered and moisture controlled. The Contractor shall follow the equipment Manufacturer's long- or short-term storage procedures as appropriate.

1.5 SEQUENCING AND SCHEDULING

- A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by the Owner.
- B. Include the Work of this Specification in the construction schedule. All demolition work shall be coordinated with the Owner including timely notification to allow relocation of control room and laboratory functions.
- C. Areas in which the Work is to be accomplished shall be limited and coordinated with the Owner prior to start.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

- A. Facilities: Areas scheduled for selective demolition, partial demolition, and renovation Work are as shown on the contract documents.
- B. Utilities and Related Equipment:
 - 1. Notify Owner to turn off affected services at least 48 hours before starting demolition or renovation activities.
 - 2. When utility lines are encountered that are not indicated on the Drawings, notify Owner prior to further work in that area.
- C. Paving, Sidewalks, and Slabs:
 - 1. Sawcut concrete to be removed as indicated on the drawings.
 - 2. Provide neat sawcuts at limits of pavement removal as indicated.
 - 3. Where proposed concrete saw cut locations coincide or fall within 3-feet of existing construction or expansion joints, remove concrete to the existing joint.
- D. Patching:
 - 1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
 - 2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
 - 3. Patching shall be as specified and indicated and shall include: Fill holes and depressions left as a result of removals in existing concrete with an approved patching material, applied in accordance with the manufacturer's printed instructions.
 - 4. Repair damaged finish surfaces to match adjacent surfaces per applicable specifications.
- E. Electrical:
 - 1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
 - 2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
 - 3. Rework existing circuits or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
 - 4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
 - 5. Raceways and cabling not scheduled for reuse.
 - 6. Inaccessibly Concealed: Cut off and abandon in place.
 - 7. Exposed or Concealed Above Accessible Ceilings: Remove.
 - 8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
 - 9. Relocating Equipment: Extend existing wiring or run new wiring from the source.

10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

F. Instrumentation and Controls:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing instruments, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).

G. Selective HVAC demolition for alterations:

1. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - a. Verify that construction and utility arrangements are as shown.
 - b. Report discrepancies to A/E before disturbing existing installation.
 - c. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
2. Remove existing work as indicated on drawings and as required to accomplish new work.
3. Perform demolition in an orderly and careful manner.
4. Protect existing materials which are not to be demolished.
5. Conduct demolition to minimize interference with adjacent building areas and to cause as little inconvenience to Owner and employees of occupying buildings as possible.
6. Existing outside air and exhaust ductwork to be removed and capped as indicated on drawings. Remove all associated insulation, fittings and supports.
7. All controls for relocation of existing VRF systems to be reconnected to match existing conditions. All control sequence shall be verified working to match existing after relocation of VRF units.
8. Existing ductwork and control wiring may be re-used where they are of the type specified, meet the requirements for the new work as defined by the contract documents, and remain in good condition.

9. Deactivation, relocation, new work shall be planned to minimize disruption of adjacent building areas. Provide temporary capping and connections as required to maintain existing systems during construction.
10. Negative pressure shall be maintained within the construction areas as referenced to non-construction areas at all times by use of negative air fan units filtered with HEPA filters. Airflow indicators must be provided so that any loss of negative pressure to the construction areas will be known immediately to those outside areas. Differential pressure shall be monitored (via magnehelic gauge). All exhaust provided in construction areas where grinding, welding, toxic fumes, etc. is present shall be vented outside of building (at least 10 ft above grade) away from all intakes in operation.
11. The project/construction site shall be completely contained with construction barriers by general contractor (G.C.)/construction manager (C.M.) the HVAC contractor will provide temporary filtration on all ducts entering or exiting the construction zone. This area shall be cleaned using high efficiency particulate air (HEPA) filtered vacuum cleaners by the general contractor/construction manager prior to occupancy.
12. Do not drop materials on floor slab which will cause damage to slab or structure.
13. Remove demolished materials from site as work progresses. Dispose of demolished materials off-site at approved legal disposal locations. Under no circumstance allow debris to accumulate.

3.2 PROTECTION

- A. Building Occupancy: Refer to Division 1, Project Coordination, for specific requirements related to concurrent occupancy of facilities to be partially demolished.
- B. Dust and Debris Control:
 1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
 2. Vacuum and dust the Work area daily.
 3. Sweep areas as often as necessary to control the spread of debris that may result in a hazardous condition.
 4. Demolition and construction debris shall not be allowed to enter in-service channels or tanks. Debris in existing areas shall be cleaned out prior to placing the facilities back in service. When working in existing areas, Contractor shall keep the work area clean in order to facilitate quick clean up and evacuation of the facility should it need to be placed in service.
- C. Existing Work:
 1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
 2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by the Owner.
 3. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.

4. Protect existing piping where new connections are to be made. Modifications to existing pipe shall be in accordance with the pipe Manufacturer's recommendations.
5. See plumbing specifications for rework of existing piping and capping of existing lines.

D. Facilities: Protect all facility elements not scheduled for demolition.

E. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the facility being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel to occupied portions of the facility.

3.3 RELOCATIONS

- F. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.4 TITLE TO MATERIALS

G. All salvaged equipment will remain the property of Owner.

H. The following specific listed equipment shall be salvaged and turned over to the Owner. In addition to the listed equipment, the Owner may at any time opt to retain possession of certain equipment and shall have first right of refusal for any equipment scheduled for demolition. All items not salvaged and turned over to the Owner shall become the property of Contractor.

1. Existing

3.5 DISPOSITION OF MATERIAL

- I. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.
- J. Salvage equipment to the maximum extent possible.
- K. Remove equipment that are indicated or specified to be salvaged and deliver to a storage area on site as directed by the Owner.
- L. Contractor shall be responsible for draining all chemical storage and feed tanks, equipment, and piping associated with the existing odor control system and properly disposing of contents.

3.6 REUSE OF MATERIALS AND EQUIPMENT

- M. Properly store and maintain equipment and materials in same condition as when removed.

- N. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.
- O. Engineer will determine condition of equipment and materials prior to removal.

3.7 CLEANUP

- P. Debris and rubbish shall be removed from the renovated areas daily. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent work areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

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SECTION 02 81 50

DECORATIVE METAL GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification includes swing gate for trash bin enclosure.
 - 1. The Basis of design includes swinging decorative metal gates as manufactured by BASTEEL Perimeter Systems, 1400 Magnolia Avenue, Frankfort, Indiana 46041, 1-866-369-8335, see <http://www.basteel.com/>.

1.2 WORK INCLUDED

- A. Contractor shall provide labor, materials and appurtenances necessary for installation of Decorative Metal Gate System defined and described herein at CITY OF ARLINGTON water Utilities Laboratory and Maintenance Building, further described within Part 2 of this specification.

1.3 RELATED WORK

- A. Section 03 30 00 Cast-In-Place Concrete: Concrete anchorage for posts.
- B. Earthwork: See Civil Specifications.

1.4 SYSTEM DESCRIPTION

- A. Manufacturer shall supply a Decorative Metal Gate System of BASTEEL Perimeter Systems Infinity Single Swing Gate System design.

1.5 QUALITY ASSURANCE

- A. The Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified. Contractor shall report in writing to Architect prevailing conditions that may adversely affect satisfactory execution of Work. 1. Do not proceed with Work until unsatisfactory conditions have been corrected.
- B. Additional qualifications: 1. Manufacturer: Company specializing in manufacturing Products specified with minimum ten (10) years documented experience. 2. Installer: Company specializing in performing Work of this Section shall have sufficient documented experience in installation of similar Products.

1.6 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A500/A500M-13: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes Infinity Single Swing Gate System BASTEEL Perimeter Systems 2017-3-31 32 31 19 - 2
 - 2. ASTM A653/A653A: Standard Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.

3. ASTM D2244: Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
 4. ASTM D4214: Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
 5. ASTM F1043: Specification for Strength and Protective Coatings for Metal Industrial Fence Framework.
- B. American Architectural Manufacturers Association (AAMA): 1. AAMA 621: Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) & Zinc-Aluminum Coated Steel Substrates.
- C. American National Standards Institute (ANSI): 1. ANSI B1.13M: Metric Screw Threads: M Profile.

1.7 SUBMITTALS

- A. Manufacturer submittal package shall be submitted in accordance with Section 03 3300 prior to installation.
- B. Manufacturer shall utilize available architectural drawings, customer conceptual drawings, available field measurements and other information initially provided by Architect to develop proposed project drawings for subsequent review and approval.
- C. Requirements for Submittals:
1. Identify Product Data from Manufacturer regarding gates, posts, accessories, fittings and hardware. Identify applicable certifications including, but not limited to following a. Made in U.S.A., Buy American Act or otherwise, as required.
 2. Specify applicable requirements related to intended use such as, but not limited to, need for licensed professional engineering (PE) certification.
 3. Provide field drawings, including plan layout showing gate location and opening size, with field dimensions, location and elevation of nearby fences, roadways and gates as well as details of attachments and footing details, as required.
NOTE: Specific footing requirements may vary due to soil conditions, frost line and other local conditions. Consult with local jurisdictional authority regarding site requirements and local conditions.
 4. Verify by field measurements that actual field dimensions and layout shown on submittal drawings accurately reflect customer installation requirements, property survey lines and existing structures.
 5. Submit quality assurance information including documentation of installer experience indicating compliance with specified qualification requirements.
 6. Manufacturer material certification shall conform to current ASTM or other applicable specifications and shall be made available upon request.

1.8 PRODUCT, HANDLING AND STORAGE

- A. Upon delivery, Contractor shall confirm materials were delivered undamaged and items necessary for installation are present on site. Contractor shall report discrepancies to Manufacturer at time they are identified, prior to beginning installation work.
- B. Requirements for Handling and Storage
1. Prior to and during installation process, protect finished metal surfaces with wrapping or strippable coating. Do not use adhesive papers or sprayed coatings that may bond to metal when exposed to sunlight or weather.

2. Materials shall be securely stored to protect against accidental damage, vandalism and theft in a manner that provides proper ventilation, drainage and protection from anticipated weather conditions.
3. Product shall be handled in a manner to preserve integrity of finish coating as well as form and function of each gate component. Infinity Single Swing Gate System BASTEEL Perimeter Systems 2017-3-31 32 31 19 - 3
4. NOTE: Failure to comply with requirements B.1, B.2 or B.3 above shall void Manufacturer Product Warranty.

1.9 PRODUCT WARRANTY

- A. Gate shall be warrantied for a period of five (5) years within specified limitations; infill components shall be warrantied for a period of (15) years as described within Manufacturer Master Warranty Statement.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The design is based on Products exclusively designed and manufactured by:
 1. BASTEEL Perimeter Systems, 1-866-369-8335; see <http://www.basteel.com/>
 2. BASTEEL product substitutions are permitted.
 3. Product Substitutions by other manufacturer shall be submitted to Architect in accordance with substitution requirements as set forth in general provisions of Project Manual.

2.2 MATERIALS

- A. Heavy duty gate hinge assemblies shall be designed for continuous duty and shall utilize precision ground pre-lubricated sealed bearing assemblies, shielded to protect against normal ambient environmental conditions such as wind, dust, dirt, damp, rain, snow and/or icing.
- B. Infill pickets 5 inches in width shall be liquid color coated and then roll formed from minimum 0.017-inchthick full-hard 80,000 psi minimum yield strength steel in accordance with ASTM A653.
 1. Protective coatings shall consist of a hot dip galvanized zinc G-90 under coat; then a two-coat, thermocured paint system consisting of a primer bottom coat and a fluoropolymer topcoat. Fluoropolymer topcoat shall contain not less than 70 percent polyvinylidene difluoride by weight (e.g. Kynar 500® PVDF resin-based coating) complying with physical properties and coating performance requirements of AAMA 621.
 2. Infill panel design from manufacturer stock BENNINGTON INFILL.
- C. Gate frame shall consist of 2.0"x 4.0" x 0.073" wall (14 gage) minimum steel tubing, reinforced with 1.0"x 2.0" x 0.060" wall (16 gage) minimum, 50,000 psi minimum yield strength steel tubing in accordance with ASTM A500, zinc coated in accordance with ASTM F1043 type B. Thermo-cured top coat protective finish layer in specified color shall consist of thermocured fluoropolymer powder coat.
- D. Standard square posts shall conform to ASTM A500 and be either of following:
 1. 4"x 4" high strength steel, 50,000 psi minimum yield strength, zinc coated per ASTM F1043 type B, or
 2. 6"x 6" steel, hot dipped galvanized to minimum 1.8 oz. per square foot per side.

- 3. Posts shall have 3-mil minimum thickness thermo-cured topcoat protective finish layer in specified color shall consist of thermocured fluoropolymer powder coat.
- E. One (1) heavy-duty industrial cane rod assembly shall be provided for each gate consisting of a 1-inch diameter stainless steel cane rod with heavy duty nylon guides.
- F. One (1) heavy-duty corrosion-resistant gate latch assembly shall be provided with provision for use of a heavy-duty pad lock to secure gate in closed position.
- G. Infill fasteners shall be series 302 stainless steel 6-Lobe pin-in security truss head, full body shouldered conforming to ANSI B1.13M with a minimum pull out tensile strength of 5,500 N. Other fasteners shall be corrosion resistant.
- H. Color Selection:
 - 1. Architect shall specify topcoat color selection from Manufacturer list of stock colors.

2.3 FABRICATION

- A. Gate frame, gate hinge assemblies, stainless steel cane rod, gate latch, posts, gate infill material and accessories shall be provided as integral components of an engineered gate system as detailed in Manufacturer shop drawings and as otherwise defined by Manufacturer.
 - 1. Gate frame shall be designed and constructed so as to be rigid and self-supporting over life of product without need for tension cables or turnbuckles to maintain overall squareness.
 - 2. Gate frame perimeter shall utilize miter cut corners and be free of sharp edges, cuts, bends and weld splatter prior to factory finish being applied.
 - 3. Gate frame welds shall utilize silicon bronze welding wire conforming to AWS A5.7 / ER CUSI-A so as to inhibit corrosion.
 - 4. Infill materials shall be incased on four sides by gate frame perimeter.

PART 3 – EXECUTION

3.1 PREPARATION

- A. New installations shall be laid out by Contractor in accordance with information provided by Architect. Verify field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

3.2 GATE INSTALLATION

- A. Contractor shall consult with local jurisdictional authorities regarding specific utility locate requirements. Contractor shall arrange for local underground utility locate service to identify and locate potential below grade utility hazards such as electric, gas, water, sewer, telecommunications and similar infrastructure prior to commencing clearing, digging, excavating or gate installation work.
- B. Contractor shall complete concrete work per Architect-provided information consistent with local jurisdictional authority requirements and gate installation in accordance with Manufacturer Installation Instructions and approved shop drawings. Mono-block carriage template, heavy duty mono-block carriage assemblies and gate posts and shall be located and spaced in accordance with Manufacturer drawings. Posts shall be set in suitable

concrete footers designed and constructed for structural integrity in specific application. Infinity Single Swing Gate System BASTEEL Perimeter Systems 2017-3-31 32 31 19 - 5

1. Setting of gate posts by other methods (e.g. base plate mounting, grouted core-drilled footers) is permissible only as determined by Architect.
 2. Should Contractor elect to substitute foundation design, Contractor shall make sure design and construction of alternate foundation design will be sufficient for intended application.
- C. Gate installation may require limited cutting or drilling to accommodate slight variations in field measurements and normal construction tolerances. Contractor shall take reasonable precautions to make sure exposed metal surfaces are properly sealed from environment, as described below:
1. Carefully inspect gate and metal components during installation.
 2. Remove metal shavings from drilling or cutting of posts or metal gate components.
 3. Where cutting or drilling was determined necessary, clean metal surfaces and apply two (2) coats of zinc-rich metal primer to thoroughly cover each cut edge or hole drilled during installation processes. Allow each coat to dry thoroughly.
 4. Next, apply two (2) thin coats of Manufacturer-supplied custom touch-up paint to such locations, allowing each coat to dry thoroughly.
 5. Inspect work and verify each cut or drilled metal surface was properly treated as described above.
 6. NOTE: Failure to properly clean, prime and finish paint exposed surfaces as described in steps 1 – 5 above shall void Manufacturer Warranty

3.3 FIELD QUALITY CONTROL

- A. Contractor shall perform Contractor quality control inspections and document findings upon completion of Work.
1. Inspect gate installation against Manufacturer information such as but not limited to post spacing, location and dimensions of gate opening and finishes.
 2. After initial installation, cycle gate through full range of motion while carefully observing gate operation to make sure gate system is free of binding, twisting or undesirable conditions. Adjust as necessary, then re-inspect as described above.
 3. Carefully inspect gate closure process to make sure correct alignment of gate, gate stops, slide bolt assembly and associated components (e.g. cane rod and lock). Adjust as necessary, then re-inspect as described above.
 4. Document preparatory, initial and follow-up inspections in Contractor Test and Inspection Reports.
 5. Contractor Test and Inspection Reports shall be made available to Architect and Manufacturer upon request.
- B. Contractor shall correct deficiencies in products and installation found to be out of compliance with Contract Documents.

3.4 CLEANING

- A. Contractor shall clean jobsite of excess gate and gate materials as well as remaining packing and shipping materials. Post hole excavation material shall be scattered uniformly away from posts unless otherwise specified within Contract Documents

END OF SECTION

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SECTION 02 82 70

SLIDING GATE OPERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions.
- B. Related Work Specified Elsewhere:
 - 1. Section 02 28 21 CHAIN LINK FENCES
 - 2. Cast in place concrete: See section 03 30 00.
 - 3. Electrical service and connections: See section 26 05 13.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Pre-wired gate operator for horizontal sliding gates, including all selected attachments and accessory equipment.
 - 2. For information, (800) 321-9947, 210-842-6445, ndinnet@hysecurity.com with the manufacturer or visit the website at www.hysecurity.com.

1.3 SUBMITTALS

- A. Shop drawings: Submit shop drawings under the provisions of Section 01 3300. Submit drawings showing connections to adjacent construction, range of travel, and all electrical and mechanical connections to the operator. All underground runs of electrical lines and inductive vehicle obstruction loop locations shall be indicated on drawings. Drawings shall also show the size and location of the concrete mounting pad.
- B. Installation Drawings: Submit two copies of manufacturer's installation instructions for this specific project.
- C. Submit two copies of manufacturer's installation instructions for this specific project.
- D. Test reports:
 - 1. Submit affidavits from the manufacturer demonstrating that the gate operator mechanism has been tested to 200,000 cycles without breakdown.
 - 2. Each operator shall bear a label indicating that the operator mechanism has been tested. Operator is tested for full power and pressure of all hydraulic components, full stress tests of all mechanical components and electrical tests of all overload devices.

1.4 QUALITY ASSURANCE

- A. Manufacturer: A company specializing in the manufacture of gate operators of the type specified, with a minimum of five years' experience manufacturing operators of this type and design.
- B. Installer: Must have a minimum of three years' experience installing similar equipment, provide proof of attending a HySecurity Technical Training within the previous three

years, or obtain other significant manufacturer endorsement of technical aptitude, if required, during the submittal process.

1.5 CODES AND REGULATORY REQUIREMENTS

- A. Operators shall be built to latest UL 325 Standards and be listed by a nationally recognized testing laboratory. Complete all electrical work according to local codes and National Electrical Code. All fieldwork shall be performed in a neat and professional manner, completed to journeyman standards.
- B. Current safety standards require the use of multiple external sensors to be capable of reversing the gate in either direction upon sensing an obstruction. See also 2.2D.
- C. Vehicular gates should never be used by pedestrians. A separate pedestrian gate must always be provided when foot traffic is present.
- D. Gate must have physical stops to prevent over travel in both the open and close directions.
- E. Current safety standards require gate operators to be designed and labeled for specific usage classes.
 - 1. HySecurity model SlideDriver™ 40 (222 E ST) is listed for use in UL 325 Usage Classes I, II, III, and IV.

1.6 PRODUCT DELIVERY AND STORAGE

- A. Comply with 01 60 00.
- B. Store products upright in the original shipping containers, covered, ventilated and protected from all weather conditions.

1.7 WARRANTY

- A. Provide a warranty against all defects in materials or workmanship for five years or 500,000 gate cycles (whichever occurs first) after the date of installation. Defective materials shall be replaced at manufacturer's discretion with new or reconditioned materials furnished by the manufacturer, at no cost to the owner. Freight, labor and other incidental costs are not covered under the factory warranty but may be covered by a separate service agreement between installing company and the owner.
 - 1. To ensure validation of warranty, complete warranty registration form online at www.hysecurity.com/warranty. Warranty registration form is also included in the printed materials shipped with the operator.

PART 2 - PRODUCTS

2.1 GATE OPERATORS

- A. Bases of design HySecurity gate operator model SlideDriver 40 (222 E ST) with Smart Touch Controller, or other comparable operator, as approved by the architect or specifier. Substitute operators that are approved will be published in an addendum, not less than ten days prior to bid opening. Requests for substitution will include the amount of savings to be passed on to the owner.

2.2 OPERATION

- A. Operation shall be by means of a metal rail passing between a pair of reinforced composite wheels with polyurethane treads. Operator motors shall be hydraulic, geroller type, and system shall not include belts, gears, pulleys, roller chains or sprockets to transfer power from operator to gate panel. The operator shall generate a minimum horizontal pull of 300 lb (136 kg) without the drive wheels slipping and without distortion of supporting arms. Operator shall be capable of handling gates weighing up to 4,000 lb (1,814 kg). Gate panel velocity shall not be less than 1 ft/s (304 mm/s) and shall be stopped gradually to prevent shock loads to the gate and operator assembly. The “soft-stop” feature of the gate operator shall be controlled by two adjustable hydraulic brake valves (one for each direction).
- B. Minimum standard mechanical components:
1. Supporting arms: Cast aluminum channel. Arms shall incorporate a fully bushed, 1 1/2" (38 mm) bronze bearing surface, acting on arm pivot pins. (item 2 below)
 2. Arm pivot pins: 3/4" (19 mm) diameter, stainless steel, with integral tabs for ease of removal.
 3. Tension spring: 2 1/2" (63 mm) heavy duty, 800 lb (363 kg) capacity.
 4. Tension adjustment: Finger tightened nut, not requiring the use of tools.
 5. Drive release: Must instantly release tension on both drive wheels and disengage them from contact with drive rail in a single motion, for manual operation.
 6. Limit switches: Fully adjustable, toggle types, with plug connection to control panel.
 7. Chassis: 1/4" (6 mm) steel base plate, and 12 Ga. (3 mm) sides and back welded and ground smooth.
 8. Cover: 16 Ga. (1 mm) zinc plated steel with textured TGIC polyester powder coat finish. All joints welded, filled and ground smooth. Finished corners square and true with no visible joints.
 9. Finish: Zinc plated steel with textured TGIC polyester powder coat finish, proven to withstand 1,000-hour salt spray test.
 10. Drive wheels: Two 6" diam (152 mm) AdvanceDrive wheels. High-strength composite hub with polyurethane over mold.
 11. Drive rail: Shall be extruded 6061 T6, not less than 1/8" (3 mm) thick. Drive rail shall incorporate alignment pins for ease of replacement or splicing. Pins shall enable a perfect butt splice.
 12. Hydraulic hose: Shall be 1/4" (6 mm) synthetic, rated to 3,000 psi (20.6 MPa).
 13. Hydraulic valves: Shall be individually replaceable cartridge type, in an integrated hydraulic manifold.
 14. Hose fittings: At manifold shall be quick-disconnect type, others shall be swivel type.
 15. Hydraulic fluid: High performance type with a viscosity index greater than 375 and temperature range -40° F to 158° F (-40° C to 70° C).
 16. A zero to 2,000 psi (13.7 MPa) pressure gauge, mounted on the manifold for diagnostics, shall be a standard component.
 17. The hydraulic fluid reservoir shall be formed from a single piece of metal, non-welded, and shall be powder painted on the inside and the outside, to prevent fluid contamination.
- C. Minimum standard electrical components:
1. Pump motor: 1 hp, 3450 RPM, 56C, TEFC. Standard voltages available in single or three phases.
 2. All components shall have overload protection.
 3. Electrical enclosure: Type 1, metal, with hinged lid gasketed for protection from intrusion of foreign objects.

4. Controls: Smart Touch Controller Board containing:
 - a. inherent entrapment sensor;
 - b. built in audible “warn before operate” system;
 - c. built in timer to close;
 - d. 32 character OLED display for reporting of functions and codes;
 - e. multiple programmable output relay options;
 - f. anti-tailgate mode;
 - g. built-in power surge/lightning strike protection;
 - h. menu configuration, event logging and system diagnostics easily accessible with a PC and HySecurity’s free Smart Touch Analyze and Retrieve Tool;
 - i. RS-232 port for connection to laptop or other computer peripheral and RS-485 connection for network interface.
 - j. Dual gate communication connection for bi-parting, sally port, or sequenced gates.
 - k. Electromechanical and solid state relays.
 - l. Radio option outputs.
 - m. 21 inputs for site specific configurations.
 5. Transformer: 75 VA, non-jumpered taps, for all common voltages.
 6. Control circuit: 24 VDC.
- D. Required external sensors: See 1.5B. Specify photo eyes or gate edges or a combination thereof to be installed such that the gate will reverse in either direction upon sensing an obstruction.
- E. Control devices:
1. card reader/intercom
 - a. To be coordinated with owners
 2. Free egress vehicle loops
 - a. As indicated on drawings
 3. Vehicle obstruction loops
 - a. As indicated on drawings
- F. Additional options:
1. Gate edge and transmitter radio reversing device.
 2. Hy5B plug in type vehicle detectors
 - a. As indicated on drawings for each loop
 3. Hy8Relay™ provides eight additional programmable user relay outputs.
 4. 460VAC three phase available. (50 Hz is available, specify voltage)

2.3 FACTORY TESTING

- A. Fully assemble and test, at the factory, each gate operator to assure smooth operation, sequencing and electrical connection integrity.
- B. Proof test with simulated physical and electrical loads to exceed the fully rated capacity of the operator components.
- C. Inspect and test all hydraulics are leak free.
- D. All testing data shall be individually logged and recorded by serial number.
- E. Check all mechanical connections for tightness and alignment. Check all welds for completeness and continuity.

- F. Inspect finishes for completeness. Touch up imperfections prior to shipment.
- G. Check all hydraulic hoses and electrical wires to assure that chafing cannot occur during shipping or operation.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Locate concrete mounting pad in accordance with approved shop drawings and in compliance with local building codes.
- B. Make sure that gate is operating smoothly under manual conditions before installation of gate operators. Do not proceed until gate panel is aligned and operates without binding.

3.2 INSTALLATION

- A. Install gate operator in accordance with the safety regulations and the manufacturer's product literature and installation instructions, current at the time of installation. Coordinate locations of operators with contract drawings; other trades and shop drawings.
- B. Installer shall ensure that the electrical service to the operator is at least 20A. Electrical wiring to conform to NEC and manufacturer's installation instructions. SlideDriver 40 is 1500W.

3.3 FIELD QUALITY CONTROL

- A. Test operator through ten full open and close cycles and adjust for operation without binding, scraping or uneven motion. Test limit switches for proper open and close limit positions.
- B. All anchor bolts shall be fully tightened in the finished installation.
- C. Owner, or owner's representative, shall complete "check list" with installing contractor prior to final acceptance of the installation and submit completed warranty documentation to manufacturer.

3.4 CONTINUED SERVICE AND DOCUMENTATION

- A. Train owner's personnel on how to safely shut off electrical power, release and manually operate the gate. Additionally, demonstrate the general maintenance of the gate operator and accessories and provide one copy of "Programming and Operations Manual" for the owner's use. Manuals will identify parts of the equipment for future procurement. Direct maintenance personnel to the technical support sections on HySecurity's website at www.hysecurity.com.

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SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Form-facing material for cast-in-place concrete.
 - 2. Form liners.
 - 3. Insulating concrete forms.
 - 4. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction, movement, contraction, and isolation joints
 - c. Forms and form-removal limitations.
 - d. Shoring and reshoring procedures.
 - e. Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Exposed surface form-facing material.
 - 2. Concealed surface form-facing material.
 - 3. Form liners.
 - 4. Form ties.
 - 5. Form-release agent.
- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.

2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).
3. Location of construction joints is subject to approval of the Architect.
4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

C. Samples:

1. For Form Liners: 12-inch by 12-inch sample, indicating texture.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC308.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
 1. Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.
- B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
 1. Provide continuous, true, and smooth concrete surfaces.
 2. Furnish in largest practicable sizes to minimize number of joints.
 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1) APA HDO (high-density overlay).
 - 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.
- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
 1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

3. Furnish ties with integral water-barrier plates to walls indicated to receive damp-proofing or waterproofing.

PART 3 EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
 1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
 1. Minimize joints.
 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 1. Provide and secure units to support screed strips
 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 1. Determine sizes and locations from trades providing such items.

2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 3. Place joints perpendicular to main reinforcement.
 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
 5. Clean embedded items immediately prior to concrete placement.

3.3 FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be dam-

aged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
1. Align and secure joints to avoid offsets.
 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel reinforcement bars.
 - 2. Welded-wire reinforcement.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction contraction and isolation joints.
 - c. Steel-reinforcement installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of steel reinforcement.
 - 2. Epoxy repair coating.
 - 3. Zinc repair material.
 - 4. Bar supports.
 - 5. Mechanical splice couplers.
 - 6. Structural thermal break insulated connection system.
- B. Shop Drawings: Comply with ACI SP-066:
 - 1. Include placing drawings that detail fabrication, bending, and placement.
 - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of

- mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- 3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
 - 1. Location of construction joints is subject to approval of the Architect.
- D. Delegated-Design Submittal: For structural thermal break insulated connection system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For testing and inspection agency.
- B. Welding certificates.
 - 1. Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
 - 2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
- D. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
 - 2. Mechanical splice couplers.
- E. Field quality-control reports.
- F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.
- C. Mockups: Reinforcing for cast-concrete formed surfaces, to demonstrate tolerances and standard of workmanship.

1. Build panel approximately 100 sq. ft. in the location indicated on Drawings or, if not indicated, as directed by Architect.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. and to avoid damaging coatings on steel reinforcement.
1. Store reinforcement to avoid contact with earth.
 2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- D. Galvanized Reinforcing Bars:
1. Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
 2. Zinc Coating: ASTM A767/A767M, Class I zinc coated after fabrication and bending.
 3. Epoxy Coating: [ASTM A775/A775M] [or] [ASTM A934/A934M] with less than 2 percent damaged coating in each 12-inch bar length.
- E. Steel Bar Mats: ASTM A185/A185M, fabricated from ASTM A615/A615M, Grade 60 deformed bars, assembled with clips.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
 - b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
 - e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- D. Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; mechanical-lap type.
- E. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
 1. Finish: Plain.
- F. Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than 0.0508 inch in diameter.
- G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.
- H. Zinc Repair Material: ASTM A780/A780M.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 1. Do not cut or puncture vapor retarder.
 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
 - 2. Stagger splices in accordance with ACI 318.
 - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.
- H. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.
 - 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
 - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 - 4. Lace overlaps with wire.
- I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.
- J. Dual-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.
- K. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material in accordance with ASTM A780/A780M.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 - 1. Steel-reinforcement placement.
 - 2. Steel-reinforcement mechanical splice couplers.
 - 3. Steel-reinforcement welding.
- D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
- 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project Site

- 1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special concrete finish Subcontractor.

2. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction joints, control joints, isolation joints, and joint-filler strips.
 - c. Semirigid joint fillers.
 - d. Vapor-retarder installation.
 - e. Anchor rod and anchorage device installation tolerances.
 - f. Cold and hot weather concreting procedures.
 - g. Concrete finishes and finishing.
 - h. Curing procedures.
 - i. Forms and form-removal limitations.
 - j. Shoring and reshoring procedures.
 - k. Methods for achieving specified floor and slab flatness and levelness.
 - l. Floor and slab flatness and levelness measurements.
 - m. Concrete repair procedures.
 - n. Concrete protection.
 - o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
 - p. Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
9. Color pigments.
10. Vapor retarders.
11. Floor and slab treatments.
12. Liquid floor treatments.
13. Curing materials.
 - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
14. Joint fillers.
15. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
11. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
12. Intended placement method.
13. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Provide as indicated in Drawings.
 - a. Location of construction joints is subject to approval of the Engineer of Record.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Form materials and form-release agents.
3. Admixtures.

4. Steel reinforcement and accessories.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.
8. Admixtures:
 - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.
 - f. Permeability.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 3. Do not use frozen materials or materials containing ice or snow.

4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 and ACI 117 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I as indicated on drawings.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Silica Fume: ASTM C1240 amorphous silica.

C. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1-inch nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
 7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
 8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
- F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class C: ASTM E1745, Class C. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.4 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch sieve.
- B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
- C. Emery Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
1. Color: Match Architect's sample.

- D. Metallic Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.
 - 1. Color: Match Architect's sample.
- E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
- F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
 - 1. Color: Match Architect's sample.

2.5 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below 50 deg F: Black.
 - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
 - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: Eight-feet-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
- G. Clear, Waterborne, Membrane-Forming, Non-dissipating Curing Compound: ASTM C309, Type 1, Class B.
- H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, non-dissipating.

- I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
- J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: Eight-feet-wide cellulose fabric.

2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.9 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash or Other Pozzolans: 25 percent by mass.
 2. Slag Cement: 50 percent by mass.
 3. Silica Fume: 10 percent by mass.
 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete for parking structure slabs, and concrete with a w/cm below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 5. Use permeability-reducing admixture in concrete mixtures where indicated.
- D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.10 CONCRETE MIXTURES

- A. As scheduled on drawings.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish batch ticket information.

- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 - 1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Daily access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
 - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 - 2. Face laps away from exposed direction of concrete pour.
 - 3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
 - 4. Lap joints 6 inches and seal with manufacturer's recommended tape.
 - 5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
 - 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 - 7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 - 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated on Drawings. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as-long-as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 3. Maintain reinforcement in position on chairs during concrete placement.
 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 5. Level concrete, cut high areas, and fill low areas.
 6. Slope surfaces uniformly to drains where required.
 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
 8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie hole and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

- a. Perform no later than one day after form removal.
- b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
- c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
- d. Maintain required patterns or variances as shown on Drawings.

2. Grout-Cleaned Rubbed Finish:

- a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
- b. Do not clean concrete surfaces as Work progresses.
- c. Mix 1-part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- d. Wet concrete surfaces.
- e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
- f. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

C. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings and to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

2. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

a. Slabs on Ground:

- 1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.
- 2) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
- 3) Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.
- 4) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.
- 5) Specified Overall Value (SOV): F_F 50 and F_L 25 with minimum local value (MLV): F_F 40 and F_L 17.
- 6) Specified Overall Value (SOV): F_F 25 and F_L 20 with minimum local value (MLV): F_F 17 and F_L 15.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps as indicated on Drawings

1. Apply in accordance with manufacturer's written instructions and as follows:
 - a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications.
 - b. Tamp aggregate flush with surface, but do not force below surface.
 - c. After broadcasting and tamping, apply float finish.
 - d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 - 1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
 - 2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
 - 3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
 - 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 - 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
 - 3. If forms remain during curing period, moist cure after loosening forms.
 - 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.
- C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
 - 1. Begin curing immediately after finishing concrete.
 - 2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12-inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

- 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.

- b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
 - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
 - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
 - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
 - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Curing Compound:
 - 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Maintain continuity of coating, and repair damage during curing period.
 - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer. Curing and sealing compound is usually for floors and slabs and may act as a permanent surface finish.
- f. Floors to Receive Curing and Sealing Compound:
 - 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

- A. Conform to ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than seven days' old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
 4. Rinse with water; remove excess material until surface is dry.
 5. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. Defer joint filling until concrete has aged at least one month.
 2. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
1. Repair and patch defective areas when approved by Architect.
 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01-inch-wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.

- c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
- 8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
 - 1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 - 2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 - 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.

- 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results.
 - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Slump Flow: ASTM C1611/C1611M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of two 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
 - c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
 - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301, section 1.6.6.3.

13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Engineer of Record.

3.16 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive polished concrete finish or sealed concrete finish using Floor Slab Protective Covering.

END OF SECTION

SECTION 04 05 03

MASONRY MORTARING-GROUTING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Applicable Standards: Conform to the following Standards:
 - 1. ASTM C 91: Masonry Cement
 - 2. ASTM C 144: Aggregate for Masonry Mortar
 - 3. ASTM C 207: Hydrated Lime for Masonry Purposes
 - 4. ASTM C 270: Mortar or Unit Masonry
- B. Tests: Prior to commencing masonry work, prepare current laboratory tests for mortar using materials proposed for use on this project. Test mortar in accordance with ASTM C 270. Prepare separate tests for each type of mortar specified.
- C. Sample Panels: Lay out a sample panel with mortar color variations until Owner approves mix and color range.

1.2 SUBMITTALS

- A. Test Reports: Submit to the Owner two copies of laboratory test reports certifying that each type of mortar meets ASTM C 270 requirements.

1.3 PRODUCT DELIVERY AND STORAGE

- A. Delivery: Deliver materials to Project site dry and in unbroken containers.
- B. Storage: Store materials above ground in waterproof shelters. Store on pallets or other approved method to protect from dampness and to minimize warehouse set.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Mortar color as selected by Owner.
- B. Masonry Cement: ASTM C 91, color grey.
- C. Lime: ASTM C 207, Type S
- D. Sand: ASTM C 144, natural, except comply with the gradations outlined below. Manufactured sand not acceptable.

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 8	95 to 100
No. 16	60 to 100

No. 30	35 to 70
No. 50	15 to 35
No. 100	2 to 15
No. 200	0 to 2

E. Water: Potable

F. Admixtures: Do not add antifreeze or accelerating compounds to mortar. Waterproofing admixture not required if waterproof type masonry cement is used. If cement-lime mortars are used at exterior walls, which do not have integral waterproofing admixture, use one of the following waterproofing admixtures:

<u>Manufacturer</u>	<u>Product</u>
Sonneborn Division of Contech, Inc.	Hydrocide Powder
Toch Brothers Division of Carboline Co.	Toxement IW Powder
Grace & Co.	Hydratite Powder

PART 3 - EXECUTION

3.1 GENERAL

A. Mortar: Bond and impermeability to moisture are the most important considerations in mortar used. Mortar and mortar materials shall conform to ASTM C 270. Owner reserves the right to choose the mix used in construction. Mix all mortars so that mortar color will match the color of the existing mortar and approved sample panel.

3.2 MORTAR

A. Proportions: Parts by volume, except where otherwise indicated. Measurement by shovel not permitted. Measure sand in a damp loose condition. Contractor has the option of using either cement-lime mortar, or masonry cement mortar, except for masonry retaining walls. Where masonry retaining walls occur, use only cement - lime mortar.

1. Cement-Lime Mortars:

<u>Mortar Type</u>	<u>Portland Cement</u>	<u>Hydrated Lime</u>	<u>Sand</u>
M	One Part	1/4 Part	Not less than 2-1/4 nor more than three times sum of volume of cement and lime used.
S	One Part	1/4 to 1/2 Part	
N	One Part	1/2 to 1-1/4 Parts	

2. Masonry Cement Mortars: Do not use masonry cement mortar at masonry retaining walls.

<u>Mortar Type</u>	<u>Portland Cement</u>	<u>Hydrated Lime</u>	<u>Sand</u>
M	One Part	One Part	Six Parts
S	1/2 Part	One Part	4-1/2 Parts
N	0 Parts	One Part	Three Parts

B. Installation of Mortar Types:

1. Type M: For installation of masonry in contact with earth.
 2. Type S: For installation of reinforced concrete masonry walls, exterior exposed walls and interior load bearing walls.
 3. Type N: For installation of interior masonry partitions and structural glazed tile.
- C. Mixing Mortar: Mix materials in mechanical batch mixer for a minimum of five minutes. Thoroughly clean mixer between batches. Mix mortar with sufficient water consistent with workability to provide maximum bond strength. If mortar begins to stiffen from evaporation, retemper mortar immediately by adding water and remixing. If mortar is not used within 1-1/2 hours of initial mixing, discard stiffened mortar and mix fresh batch of mortar.

3.3 MASONRY GROUT

- A. Proportions: Parts by volume. Measurement by shovel not permitted.
- | <u>Portland Cement</u> | <u>Sand</u> | <u>Coarse Aggregate</u> |
|------------------------|-------------|---------------------------------|
| One Part | 2-1/2 Parts | 1-1/2 Parts (Maximum size 3/8") |
- B. Mixing Grout: Mix materials in a mechanical batch mixer for a minimum of five minutes. Add sufficient water to provide a fluid mix.

END OF SECTION

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SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This Section includes:
 - 1. Interior concrete masonry work at Electrical, Mechanical, Cylinder, and Archive/Safe Rooms.
- B. Industry standards governing this work of the latest issue at the date of this specification release, except as otherwise noted:
 - 1. American Society for Testing and Materials (ASTM):
 - ASTM C 55 Concrete Building Brick
 - ASTM C 90 Hollow Load-Bearing Concrete Masonry Units
 - ASTM C 140 Sampling and Testing Concrete Masonry Units
 - 2. Underwriters Laboratories, Inc. (UL)
 - UL 618 Standard for Concrete Masonry Units
 - UL 263 Standard for Fire Tests of Building Construction and Materials
 - 3. American Concrete Institute (ACI):
 - ACI 531.1 Specification for Concrete Masonry Construction

1.2 QUALITY ASSURANCE

- A. Masonry tolerances shall not exceed the following:
 - 1. Plumb:
 - a. 3/8 inch in 10'-0";
 - b. 5/8 inch in any 40'-0" or more; except,
 - c. 1/4 inch in any 10'-0" and 1/2 inch in 40'-0" or more at external corners, expansion joints, and jambs at masonry openings.
 - 2. Level:
 - a. 3/8 inch in any bay or 20'-0" maximum, and
 - b. 3/4 inch in 40'-0" or more
 - 3. Building Line:
 - a. 5/8 inch in any bay or 20'-0" maximum, and
 - b. 3/4 inch in 40'-0" or more.
 - 4. Cross-Sectional Dimension of Multiple Wythes"
 - a. 1/4 inch less, and
 - b. 1/2 inch more.
 - 5. Bed Joint:
 - a. Thickness: Plus or minus 1/8 inch
 - b. Level: Plus or minus 1/4 inch in ten feet, 1/2 inch maximum

6. Head Joint:
 - a. Thickness: Plus or minus 1/8 inch
 - b. Vertical Alignment: Plus or minus 1/4 inch in ten feet, 1/2 inch maximum.
 7. Reinforcing bar tolerances shall not exceed the following:
 - a. Fabrication:
 - 1) Sheared Length: Plus or minus one inch.
 - 2) Stirrup and Tie Dimensions: Plus or minus 1/2 inch.
 - 3) Other Bends: Plus or minus one inch.
 - b. Vertical Placement:
 - 1) Variation in Spacing from Face of Masonry: Plus or minus 1/4 inch.
 - 2) Variation in Spacing in Longitudinal Run of Masonry: Plus or minus two inches.
 - c. Horizontal Placement:
 - 1) Variation in Spacing Perpendicular to Face of Masonry: Plus or minus 1/4 inch.
- B. Job Mock-up:
1. Before installation of concrete unit masonry, erect at job site a sample wall panel for each type of finish masonry.
 2. Size: 6'-0" x 4'-0".
 3. Local panel where it can be viewed from a distance of at least 20'-0" and where it may remain in place until masonry work is complete.
 4. Panel shall indicate:
 - a. Range in color and texture of concrete masonry unit.
 - b. Type of joint.
 - c. Masonry bond.
 - d. Masonry workmanship.
 5. Relay panel until it is accepted by Owner's Representative.
 6. Accepted panel shall be the standard which the Project masonry work shall match. Maintain this sample panel until all masonry work on the project has been accepted.
- C. Surface and Edge Defects: Concrete unit masonry exposed in finished work shall be reasonably straight and true with finished faces and edges free from chips, crazes, blisters, and other imperfections detracting from appearance of finished wall when viewed at a distance of 10'-0" at right angles from wall.

1.3 SUBMITTALS

- A. Prior to ordering or delivery of materials, submit to the Owner for approval, two block units representative of each block type to be used. Texture, profile, and color shall be consistent with job mock-up and all installed masonry work.
- B. Test Reports and Certificates - Concrete Unit Masonry:
 1. Submit certificates of compliance with the Specifications to Owner for review prior to material delivery.

2. Each delivery of masonry shall have a copy of test report for moisture and strength of units being delivered.
3. Grouting method proposed, whether low-lift or high-lift grouting, if applicable.

1.4 DELIVERY, STORAGE AND HANDLING

A. Product Handling:

1. Deliver concrete unit masonry on pallet adequately secured. Handle during shipment and storage in manner to prevent damage of surfaces and edges.
2. Stack concrete unit masonry and installation material on platforms, off ground, and cover to protect from stains and weather exposure with waterproof cover.

1.5 PROJECT/SITE CONDITIONS

A. Weather Requirements:

1. Maintain air temperature above 40°F on both sides of freshly laid masonry and 40°F for freshly grouted masonry for at least 48 hours.
2. Ensure temperature of masonry units is 40°F or more when laid.
3. Hot Weather-Low Humidity Requirements, When Approved by Owner's Representative: Prevent rapid drying. The mortar bedding surfaces may be lightly wetted. Keep mortar moist, and do not string out on the wall so far ahead of units being placed that drying will take place prior to placement of units. After units are in place, a very light fogs spray should be applied several times during the first 24 hours for proper curing. Take similar precautions against rapid drying in very windy weather.

B. Protection of Work:

1. During erection, keep walls dry by covering at end of each day or shutdown period with a waterproof membrane.
2. Similarly protect partially completed walls not being worked on.
3. Covering shall overhang at least 2'-0" on each side of wall and shall be securely anchored.
4. Protect finished exposed work from stains.
5. Mortar droppings that stick to concrete block faces shall be allowed to dry, and then be removed with trowel and by lightly scrubbing surface with bristled brush.
6. Keep concrete block clean as it is laid.
7. Damaged installed materials shall be removed and replaced with new material at no additional expense to the Owner.
8. Masonry walls and partitions above normal allowable heights shall be braced or reinforced, temporarily or permanently as required, in accordance with the requirements of the local governing codes.

C. Inspect job for conditions which would prevent execution of this work as specified. Do not proceed until such conditions are corrected.

1.6 SEQUENCING/SCHEDULING

A. Coordination:

1. Before commencing work, lay out vertical and horizontal coursing to achieve bond pattern indicated, and coordinate with other masonry work.
2. Locate on story pole each joint to receive horizontal joint reinforcing and anchors to adjacent construction. Relate joints to floor elevations and other work lines.
3. Do not enclose or cover up mechanical, electrical or other work, until such work has been installed and accepted.
4. Provide open joints for calking where indicated. Calking shall be furnished and installed by others.

PART 2 PRODUCTS

2.1 MORTAR

- A. Mortar shall Type as specified in Section 04 05 03 - Masonry Mortaring Grouting.

2.2 CONCRETE MASONRY UNITS

A. General:

1. Exposed surfaces of concrete unit masonry shall have a dense finish suitable to receive paint. Appearance of exposed surfaces is of primary importance.
2. Masonry units specified to conform to ASTM C 90 shall have largest face shell thickness noted therein for minimum face shell thickness of each size unit.
3. Above Grade Concrete Masonry Units:
 - a. Interior and Exterior Non-Fire-Rated Block: ASTM C 90, Grade N, ASTM C-33-N.W. aggregate.
4. Miscellaneous Concrete Masonry Units:
 - a. Lintel Block and Other Special Shapes: ASTM C 90, grade and aggregate to match that of adjacent masonry.

- B. Cure concrete masonry units by either autoclave or low pressure steam treatment.

C. Standard Block:

1. Block shall have sharply formed edges and be straight with face texture and color within the approved limits.
2. Provide special shapes required for starters, jambs, corners, lintels, and sash block with exposed faces matching in color and texture and other standard block.
3. 8" thick block: Actual face size shall be 7-5/8 inches by 15-5/8 inches.

D. Special Block:

1. Comply with above specifications except as modified.
2. Bond beams and lintel blocks shall be as indicated.
3. Provide bullnose corners at exposed external corners of interior block.

2.3 MASONRY ACCESSORIES

- A. Horizontal joint reinforcement as indicated on the Drawings.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove laitance, loose aggregate, and anything that prevents mortar from bonding to foundation.
- B. Before starting to lay masonry units, determine that all required dowels from foundation have been installed.
- C. Do not proceed with masonry construction, until permitted, when the following foundation tolerances are not met:
 - 1. Horizontal Alignment: Plus or minus 1/4 inch in ten feet (variation from plan dimension) 1/2 inch maximum variation.
 - 2. Vertical Alignment: Plus or minus 1/4 inch in ten feet (variation from level) 1/2 inch maximum variation.

3.2 JOB LAYOUT

- A. Horizontal:
 - 1. Layout coursing in horizontal shall fit openings and offsets.
 - 2. Avoid slivers of concrete masonry units less than four inches wide. Cut masonry units shall have at least one web. Cut shell pieces will be permitted.
- B. Vertical:
 - 1. Maintain story pole marked with courses to work with head and sill of openings and to maintain uniform jointing.
 - 2. Indicate bed joints to receive joint reinforcing, ties and anchors.
 - 3. Coordinate story pole with joint coursing of back-up masonry.
- C. Bond:
 - 1. Concealed Masonry:
 - a. Bond units in a wythe in running bond.
 - b. Bond and interlock each course of each wythe at corner.
 - 2. Exposed interior Concrete Masonry: Lay in running bond with vertical joint in each course centered on units in course above and below.
 - 3. Exposed exterior Concrete Masonry: Lay each wythe in running bond.

3.3 WORKMANSHIP

- A. Lay masonry plumb, true to line, with level and accurately spaced courses.
- B. Finished work shall be within specified tolerances and match accepted job mock-up sample panels.

- C. Lay corners and reveals plumb. Avoid over plumbing and pounding of corners and jambs to fit stretcher units after they are set in position.
- D. Where adjustment must be made after mortar has started to harden, remove and replace mortar with fresh mortar.
- E. Keep bed and head joints uniform in width. Joint thickness shall be 3/8 inch.
- F. Cutting and punching of finish masonry to accommodate work of other trades shall be done so as not to damage or mar appearance of adjoining masonry.
- G. Cut edges of units exposed in finished wall with an abrasive power saw.
- H. Chases, wall cavities, and raked-out joint shall be kept free from mortar and other debris.
- I. Lintels and bond beams, unless otherwise indicated, shall be built-in place and filled with grout as specified. Reinforce units as noted on Drawings, or if not noted, with not less than two No. 5 bars the full length. Lintels shall extend beyond each side of the opening a minimum of sixteen inches unless otherwise noted. Provide corner bars at bond beam corners and lap splice straight bars standard lay length.
- J. Vertical cells of standard masonry units and pilaster units to be filled shall be aligned to maintain a clear, unobstructed, continuous vertical cell. Units containing reinforcement shall be solid filled with grout as specified.

3.4 JOINING OF WORK

- A. Exposed surfaces of partially or totally set masonry shall be cleaned before laying adjoining fresh masonry. Loose masonry and mortar shall be removed.
- B. If it is necessary to stop off a horizontal run of masonry, rack back one-half concrete masonry unit length in each course. Tothing will not be permitted.
- C. Intersecting walls shall be keyed together by masonry anchors, joint reinforcement or wire mesh, as indicated. Embed bent ends of anchors and strap anchors into cores of units filled with mortar or grout.

3.5 BUILDING-IN OF OTHER WORK

- A. Build in horizontal joint reinforcement in all masonry walls spaced 16 inches vertically. Provide prefabricated corner units at corners. Lap longitudinal joints not less than six inches. Reinforcing shall be installed in the three courses above all openings and extend 1'-0" beyond each side of opening. Place joint reinforcement so that longitudinal wires are located over face shell mortar beds and are embedded in mortar for their entire length with minimum cover of 1 5/8 inch when exposed to weather and 1/2 inch at other locations.

- B. Build in work of other trades indicated shall be built into masonry, including anchors, wall plugs, expansion joints, and accessories, as erection progresses. Space and align built-in parts as indicated and do not displace other materials from position.
- C. Fill in spaces around built-in items with grout or mortar.
- D. Fill pressed metal frames in masonry walls with mortar or grout as wall is laid. Maintain door mute holes open.
- E. Where indicated, rake back 1/2-inch joint between metal frames and adjacent masonry to receive caulking.
- F. Steel channel frames for openings thru masonry walls shall be installed under this Section as specified in Section 05 50 00, or as shown on Drawings. Fill spaces around frames solid with grout as specified.

3.6 MORTARING

- A. Bed Joints:
 - 1. Lay first course of standard blocks and all courses of rated blocks in full bed of mortar.
 - 2. On masonry piers, columns, and pilasters spread full mortar beds on face shell and webs of block already laid.
 - 3. On all other bed joints apply mortar on face shells only of block already laid.
 - 4. On block to be laid apply a beveled buttering to face shells to ensure filled bed joints.
 - 5. On walls to be grouted, spread full mortar beds on face shells and webs where adjacent to cells or cavities to be reinforced or filled with grout.
 - 6. Place solid units with full bed joints.
- B. Head Joints:
 - 1. Apply mortar to vertical face shells on both the block already laid and the block to be laid to ensure a filling head joint.
 - 2. Mortar shall have a minimum depth from each block face equal to the masonry unit face shell thickness.
 - 3. Place solid units with full head joints.
- C. Place block by rolling it slightly to a vertical position and shoving it against adjacent block achieving its position and alignment with a minimum of adjusting.
- D. Adjustment shall be made only while mortar is still soft and plastic by tapping lightly to plumb and bring in alignment.
- E. Check each unit as laid with level for plumbness with wall below.
- F. Concrete masonry units shall be dry when laid.

3.7 EXPANSION JOINTS

- A. Make joints of width indicated.
- B. Keep joint clear of mortar.
- C. Stop horizontal joint reinforcement one inch from joint.
- D. Build in expansion joint as detailed on Drawings.
- E. Make joint 1/2 inch wide, except where otherwise indicated.
- F. Keep joint clear of mortar by temporarily filling it with fiberboard as wall is laid.
- G. Stop horizontal joint reinforcement one inch from joint.
- H. Leave joint open and clean for caulking.
- I. Build in compressed joint seal where indicated.
- J. Provide expansion joints as indicated on the Drawings. Where not shown, locate at intervals not exceeding 40 feet or three times the wall height, whichever is less.
- K. Extend control joints through bond beams unless noted otherwise on Drawings.

3.8 JOINT TREATMENT

- A. Flush Joints: Joints in masonry to receive finish work of other trades shall be struck flush.
- B. Facing Concrete Masonry Joint: Exposed joints in concrete masonry shall be struck flush and when partially set tooled concave with a tool (aluminum tool not permitted) to squeeze mortar into joint producing continuous pressure on mortar against edge of block, both sides of joints. Finish joint shall match joints in accepted mock-up sample.
- C. Correction of Joints: Cut out defective joints, refill with mortar, and retool to match adjacent work.

3.9 REINFORCING STEEL

- A. Condition:
 - 1. Reinforcing steel shall be clean and free from defects. Loose mill or rust scale, or other coatings that will reduce bond.
 - 2. Do not use reinforcing with kinks or unrequired bends.
 - 3. Do not straighten or repair bars in a manner that will damage the bar or adjacent construction.

- B. Fabrication:
 - 1. Fabricate bars without damaging the materials.
 - 2. Perform bending on unheated bars.
 - 3. Bars larger than No. 5 shall be field bent unless approved by A/E.
 - 4. Perform bending and fabricate standard hooks in accordance with ACI 531.1.
 - 5. Provide standard lap length for splices of 48 bar diameters.
 - 6. Do not weld or tack-weld reinforcing bars.
- C. Installation:
 - 1. Center vertical reinforcing bar in cell unless noted otherwise on Drawings.
 - 2. Rigidly secure vertical bars at top and bottom and at intervals of 192 bar diameters or ten feet maximum on center, whichever is less.

3.10 GROUTING

- A. General:
 - 1. Set reinforcing steel and anchors in required position and secure against displacement before grouting is started.
 - 2. Freshly mix grout and place in cores while fluid and before initial set has taken place. Puddle or vibrate grout into place.
 - 3. Grout beams over openings in one continuous operation.
 - 4. Grout vertical cores in maximum of five feet lifts. Stop grout pours in vertical cores 1-1/2 inches below a mortar joint, except at top of wall.
 - 5. Use metal lath, mortar, or special units to confine grout to area required. Do not use materials which may inhibit bond or are combustible.
 - 6. Place grout in such a way as to prevent segregation of materials. Pour grout fluid enough to flow into all crevices of grout spaces leaving no voids.
- B. Low-Lift Grouting:
 - 1. To utilize low-lift grouting method, vertical cores to be grouted shall have minimum clear distance between sides of the core of two inches and clear area of eight square inches.
 - 2. Limit low-lift grouting to maximum wall height of five feet per lift.
 - 3. Do not erect masonry to a height of more than five feet before grouting.
- C. High-Lift Grouting:
 - 1. To utilize high-lift grouting method, conform to the following:
 - a. Vertical cores to be grouted shall be minimum clear dimension between sides of the core of three inches and clear area of ten square inches.
 - b. Provide cleanout openings of twelve square inches minimum area opposite each vertical bar at bottom course.
 - 2. Clean cores of mortar droppings and foreign material, position reinforcement and close cleanout openings before grouting starts.
 - 3. To limit horizontal flow of grout, place vertical barriers consisting of masonry units and mortar in bond beam type hollow units and mortar in bond beam type hollow units to be grouted at 30 feet maximum.

4. Pour grout in five foot lifts maximum allowing minimum of 30 minutes and maximum of one hour before pouring next lift. Grout shall be consolidated by puddling or vibrating at time of pouring and then reconsolidated before plasticity is lost. Reconsolidation may occur as next lift is poured.
 5. Do not erect masonry to a height more than 80 times the minimum clear grout space before grouting, with a maximum of 15 feet, unless approved by A/E.
- D. Construction Protection:
1. Do not use high-lift grouting method until masonry units have been in place three days minimum.
 2. Do not permit water or foreign material to fall in grout space while grout is being placed and curing.

3.11 CLEANING

- A. Clean block as it is laid as specified.
- B. Block work exposed to view shall be left clean and free of dirt, stains, discolorations, or blemishes.
- C. Cleaning methods and materials shall be in accordance with manufacturer's instructions of the masonry unit cleaned.
- D. Protect corrodible parts, such as metal frames, lintels, etc., from corrosive cleaning materials.
- E. No muriatic acid shall be used.

END OF SECTION

SECTION 04 22 23

ARCHITECTURAL CONCRETE UNIT MASONRY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Burnished concrete unit masonry.

1.2 REFERENCES

- A. ASTM International (ASTM) (www.astm.org):
 - 1. A 153/ A153M - Standard Specification for Zinc-Coating (Hot Dip) on Iron and Steel Hardware.
 - 2. A 615/ A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 3. A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 4. A 951 - Standard Specification for Masonry Joint Reinforcement.
 - 5. C 90 - Standard Specification for Hollow Loadbearing Concrete Masonry Units.
 - 6. C 129 - Standard Specification for Hollow Nonloadbearing Concrete Masonry Units.
 - 7. C 144 - Standard Specification for Aggregate for Masonry Mortar.
 - 8. C 150 - Standard Specification for Portland Cement.
 - 9. C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.
 - 10. C 404 - Standard Specification for Aggregates for Masonry Grout.
 - 11. C 476 - Standard Specification for Mortar and Grout for Reinforced Masonry.
- B. The Masonry Society (TMS):
 - 1. 402 - Building Code for Masonry Structures.
 - 2. 602 - Specification for Masonry Structures.

1.3 SUBMITTALS

- A. Product Data: Provide information on reinforcing and anchors including sizes, profiles, materials, and finishes.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 5 years documented experience in work of this section.
- B. Mockup:
 - 1. Size: 4 feet high x 8 feet wide.
 - 2. Show:
 - a. Masonry color and texture range.
 - b. Mortar joint size, color, and profile.
 - c. Each bond pattern.
 - d. Anchors.
 - e. Flashings and weeps.
 - 3. Locate where directed facing south.

- C. Perform Work in accordance with TMS 402 and 602.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store masonry off ground; prevent contact with materials that could cause staining or damage.
- B. Protect reinforcement and anchors from corrosion.

1.6 PROJECT CONDITIONS

- A. Wall Protection:
 - 1. During erection, cover tops of partially completed walls with strong waterproof membrane at end of each day or work stoppage.
 - 2. Extend cover minimum of 24 inches down both sides; hold securely in place.
- B. Load Application:
 - 1. Do not apply uniform loads for at least 12 hours after building masonry columns or walls.
 - 2. Do not apply concentrated loads for at least 3 days after building masonry columns or walls.
- C. Environmental Requirements:
 - 1. Hot weather requirements: If ambient temperature is over 95 degrees F or relative humidity is less than 50 percent, protect from direct sun and wind exposure for minimum 48 hours after installation.
 - 2. Cold weather requirements: Do not use frozen materials or build on frozen work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer - Concrete Masonry Units: Texas Building Products, Inc. (phone 800.368.1024 web site: www.texasbuildingproducts.com).
- B. Acceptable Manufacturers - Masonry Accessories:
 - 1. Blok-Lok Ltd. (www.blok-lok.com)
 - 2. Dur-O-Wal. (www.dur-o-wal.com)
 - 3. Heckmann Building Products. (www.heckmannbuildingprods.com)
 - 4. Hohmann and Barnard, Inc. (www.h-b.com)
- C. Acceptable Manufacturers - Colorants:
 - 1. Arizona Oxides LLC. (www.arizonaoxides.com)
 - 2. Davis Colors. (www.daviscolors.com)
 - 3. Lambert Southwest (www.lambertsw.com)
 - 4. Solomon Colors. (www.solomoncolors.com)

2.2 MATERIALS

- A. Burnished Concrete Unit Masonry:
 - 1. ASTM C 129, hollow non-load bearing type, normal weight.
 - 2. Sizes:
 - a. Nominally 4 inches high x 16 inches long x thickness(es) indicated

- b. Nominally 8 inches high x 16 inches long x thickness(es) indicated.
3. Provide manufacturer's standard burnished concrete unit masonry; color(s) as selected from manufacturer's complete color line.
4. `Special shapes: Solid Window Sill units.

2.3 ACCESSORIES

- A. Mortar:
 1. Portland Cement: ASTM C 150, Type I. For exposed surfaces, provide cement from one source throughout project.
 - a. Provide white Portland cement for colored mortar used in laying burnished concrete unit masonry.
 2. Aggregate: ASTM C 144, standard masonry type. For exposed surfaces, provide aggregate from one source throughout project.
 3. Lime: ASTM C 207, Type S.
 4. Colorant: Pure mineral oxide type manufactured by one of the listed manufacturers; color to be selected from manufacturer's full color range.
 5. Water: Clean and free from oils, acids, alkalies, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.
- B. Mortar Mixes: ASTM C 270 using the Proportion Method. Type N gray color.
 1. Mixing: Mix mortar in accordance with ASTM C 270.
 - a. Thoroughly mix ingredients in quantities needed for immediate use.
 - b. Discard lumpy, caked, frozen, and hardened mixes.
 2. Colorant may not exceed 9 pounds per 94-pound bag of cement for mineral oxides.
 3. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without Architect's approval.
- C. Grout:
 1. Portland Cement: ASTM C150, Type I.
 2. Aggregate: ASTM C 404.
 3. Lime: ASTM C 207, Type S.
 4. Water: Clean and free from oils, acids, alkalies, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.
- D. Grout Mix:
 1. ASTM C 476, fine grout.
 2. Compressive strength: Minimum 2500 psi at 28 days.
 3. Slump: 7 to 8 inches.
 4. Mixing: Mix grout in accordance with ASTM C 476.
 - a. Thoroughly mix ingredients in quantities needed for immediate use.
 - b. Mix dry ingredients mechanically until uniformly distributed; add water to achieve workable consistency.
 - c. Discard lumpy, caked, frozen, and hardened mixes.
 - d. Use grout within 2-1/2 hours after initial mixing at ambient temperatures below 80 degrees F. and within 1-1/2 hours after initial mixing at ambient temperatures over 80 degrees F.
- E. Single Wythe Joint Reinforcement:
 1. Truss type; ASTM A 951, hot-dip galvanized steel wire, 9 gage side rods with 9 gage cross ties.
 2. Width: Nominal wall thickness less 1-1/2 inches.
 3. Corner and tee fittings: Type to match reinforcement.

- F. Double Wythe Joint Reinforcement:
 - 1. Truss type; ASTM A 951, hot-dip galvanized steel wire, 9 gage side rods with 9 gage cross ties.
 - 2. Width: Nominal wall thickness less 1-1/2 inches.
 - 3. Corner and tee fittings: Type to match reinforcement.
- G. Veneer Ties: Formed steel wire, 9 gage thickness, two-piece adjustable type with backing plate, hot dip galvanized, ASTM A 153/A 153M, B2 finish.
- H. Fasteners: Stainless or Fluoropolymer coated steel screws, minimum 3/4-inch penetration into framing. Reinforcing Bars:
 - 1. ASTM A 615/A 615M, deformed billet steel, Grade 60.
- I. Cleaner:
 - 1. Split-face Concrete Unit Masonry: SureKlean® Custom Masonry Cleaner by Prosoco, Inc. (phone 800.255.4255 web site: www.prosoco.com).
 - 2. Burnished Concrete Unit Masonry: SureKlean® Burnished Custom Masonry Cleaner by Prosoco, Inc. (phone 800.255.4255 web site: www.prosoco.com).
 - 3. Polished Concrete Unit Masonry: None
- J. Enhancer: Ground face block Enhancer as recommended by Texas Building Products, Inc. (800.368.1024 web site: www.texasbuildingproducts.com).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Establish lines, levels and courses indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimensions. Form horizontal and vertical joints of uniform thickness.
- C. Lay concrete masonry in running bond. Course one masonry unit and one mortar joint to equal 8 inches.
- D. Lay masonry plumb and level. Do not adjust masonry units after mortar has set.
- E. Lay solid masonry units in full mortar bed, with full head joints. Lay hollow masonry units with face shell bedding on head and bed joints.
- F. Do not butter corners or excessively furrow joints.
- G. Machine cut masonry with straight cuts and clean edges; prevent oversized or undersized joints. Discard damaged units. Do not expose cut cells.
- H. Isolate masonry from structural members with compressible filler.
- I. When joining fresh masonry to partially set masonry, remove loose masonry and mortar, clean and lightly wet exposed surface of set masonry.
- J. Stop horizontal runs by racking back normal bond unit in each course. Toothing not permitted.

- K. Horizontal Reinforcement:
1. Place reinforcement at maximum 16 inches on center vertically, at topmost course, and at first two courses above and below openings.
 2. Extend minimum 24 inches each side of openings.
 3. Center reinforcing in wall.
 4. Lap ends 6 inches minimum; use fabricated tee and corner fittings at corners and intersections.
- L. Secure masonry to structural members with wall ties spaced maximum 16 inches on center.
- M. Veneer Ties:
1. Space ties to provide one tie per 2 square feet at maximum spacing of 16 inches on center horizontally.
 2. Locate ties within 3 inches of ends of masonry walls and openings.
- N. Control Joints:
1. Do not continue horizontal joint reinforcement through joints.
 2. Keep joints free from mortar and grout.
 3. Install joint backing and joint sealer at control joints in accordance with Section 07 92 00.
 4. Form expansion joint as indicated on drawings.
- O. Finishing Mortar Joints:
1. Exposed locations: Tool joints to concave profile.
 2. Concealed locations: Cut joints flush.
- P. Reinforcing Bars:
1. Position reinforcing accurately and hold securely in place to prevent displacement. Maintain minimum 1-inch space between masonry and reinforcing.
 2. Grout at intervals of not more than 60 inches in 6 to 8-inch lifts.
 3. Vibrate grout during and after placement to ensure complete filling.
 4. Stop grout 1-1/2 inch below top of masonry if grouting is stopped for 1 hour or more, except where completing grouting of finished wall.
- Q. Installation Tolerances; Maximum variation from:
1. Alignment of columns and pilasters: Plus or minus 1/4 inch.
 2. Alignment face to face of adjacent units: Plus or minus 1/8 inch.
 3. Vertical alignment of head joints: Plus or minus 1/2 inch in 10 feet.
 4. True plane of wall: Plus or minus 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.
 5. Plumb: Plus or minus 1/4 inch in 10 feet non-cumulative; 1/2 inch in 20 feet or more.
 6. Level coursing: Plus or minus 1/8 inch in 3 feet; 1/4 inch in 10 feet; 1/2 inch in 30 feet.
 7. Joint thickness: Plus or minus 1/8 inch.
 8. Cross sectional thickness of walls: Plus or minus 1/4 inch.

3.2 CLEANING

- A. Protect adjacent and underlying surfaces.
- B. Apply masonry cleaner in accordance with manufacturer's instructions.

- C. Thoroughly rinse surfaces with clean water after completion of cleaning; remove all traces of cleaning solution.
- D. Do NOT use water-blast cleaning of architectural concrete unit masonry.
- E. Do not use muriatic acid for cleaning.
- F. Clean polished concrete unit masonry as you go using moist burlap rags or similar.
- G. For burnished block, upon completion of cleaning process, apply burnished block enhancer as recommended by Texas Building Products if needed.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Structural steel.
 - 2. Shrinkage-resistant grout.

- B. Related Requirements:

- 1. Section 05 50 00 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
 - 2. Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" for surface-preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Column base plates thicker than 2 inches.

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.

1.6 ACTION SUBMITTALS

- A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Anchor rods.
4. Threaded rods.
5. Shop primer.
6. Galvanized-steel primer.
7. Etching cleaner.
8. Galvanized repair paint.
9. Shrinkage-resistant grout.

- B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members not to be shop primed.

- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

- D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installer, fabricator, shop-painting applicators, professional engineer, testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 - 2. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 3. Shop Primers
 - 4. Non-shrink grout
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Shop-Painting Applicators: Qualified in accordance with AISC's Sophisticated Paint or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators".
- D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
 - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 1. ANSI/AISC 303.
 2. ANSI/AISC 360.
 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 1. Provide details of connections required by the Contract Documents to be selected or completed by the structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
 - a. Select and complete connections using schematic details indicated and ANSI/AISC 360.
 - b. Use Load and Resistance Factor Design; data are given at factored-load level.
- C. Moment Connections: Type FR, fully restrained.
- D. Construction: Combined system of moment frame and braced frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M
- B. Channels, Angles: ASTM A36/A36M
- C. Plate and Bar: ASTM A36/A36M
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
 1. Weight Class: As indicated on drawings.
 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
- C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Headed Stud Connectors: ASTM A108, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 55.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 5. Finish: Plain.

2.5 PRIMER

- A. Steel Primer:
 - 1. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting".
 - 2. SSPC-Paint 23, latex primer.
 - 3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: MPI#26, MPI#80, MPI#134.
 - 1. Etching Cleaner: MPI#25, for galvanized steel.
 - 2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.6 SHRINKAGE-RESISTANT GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1, SSPC-SP 2, or SSPC-SP 3.
- F. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- G. Welded-Steel Door Frames: Build up welded-steel door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.
- H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened, unless otherwise noted.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 - 2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

2.10 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces of high-strength bolted, slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
 - 6. Corrosion-resisting (weathering) steel surfaces.
 - 7. Surfaces enclosed in interior construction.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
 - 3. SSPC-SP 7 (WAB)/NACE WAB-4.
 - 4. SSPC-SP 14 (WAB)/NACE WAB-8.
 - 5. SSPC-SP 11.
 - 6. SSPC-SP 6 (WAB)/NACE WAB-3.
 - 7. SSPC-SP 10 (WAB)/NACE WAB-2.
 - 8. SSPC-SP 5 (WAB)/NACE WAB-1.
 - 9. SSPC-SP 8.

- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
 - 1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 - 2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 - 4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
 - 5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.
 - 1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by the Engineer of Record. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
1. Joint Type: Snug tightened, unless otherwise noted.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - 1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.

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SECTION 05 21 00

STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. K-series steel joists.
 - 2. KCS-type K-series steel joists.
 - 3. K-series steel joist substitutes.
 - 4. Steel joist accessories.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.
- B. Sustainable Design Submittals:
- C. Shop Drawings:
 - 1. Include layout, designation, number, type, location, and spacing of joists.
 - 2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
 - 3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.

- B. Welding certificates.
- C. Manufacturer certificates.
- D. Mill Certificates: For each type of bolt.
- E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.
- F. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.
 - 1. Use LRFD; data are given at factored-load level.
 - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: Vertical deflection of 1/360 of the span.

2.2 STEEL JOISTS

- A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
 2. K-Series Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
 3. Provide holes in chord members for connecting and securing other construction to joists.
 4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
 5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated on Drawings, complying with SJI's "Specifications."
 6. Camber joists as necessary according to SJI's "Specifications".
 7. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.3 PRIMERS

- A. Primer:
1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.4 STEEL JOIST ACCESSORIES

- A. Bridging:
1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings.
- C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."
- D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.
1. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated on Drawings.
 2. Finish: Plain
- E. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain

- F. Welding Electrodes: Comply with AWS standards.
- G. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.
- H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.
- D. Shop priming of joists and joist accessories is specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications", joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and

procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Touchup Painting:
 - 1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - b. Apply a compatible primer of same type as primer used on adjacent surfaces.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709.
 - c. Ultrasonic Testing: ASTM E164.
 - d. Radiographic Testing: ASTM E94.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

END OF SECTION

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SECTION 05 31 00

STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Roof deck.
 - 2. Composite floor deck.

- B. Related Requirements:

- 1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
 - 2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.
 - 3. Section 05 50 00 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
 - 4. Section 09 91 13 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
 - 5. Section 09 91 23 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:

- 1. Roof deck.
 - 2. Non-Composite floor deck.

- B. Shop Drawings:

- 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Product Certificates: For each type of steel deck.
- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.
- D. Research Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its RoofNav for Class 1 fire rating and Class 1-90 windstorm ratings. Identify materials with FM Approvals Certification markings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G90 zinc coating.
 2. Deck Profile: As indicated.
 3. Profile Depth: As indicated.
 4. Design Uncoated-Steel Thickness: As indicated.
 5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
 6. Span Condition: Triple span or more.
 7. Side Laps: Overlapped.

2.3 NONCOMPOSITE FORM DECK

- A. Non-composite Form Deck: Fabricate ribbed-steel sheet non-composite form-deck panels to comply with "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G90 zinc coating.
 2. Profile Depth: As indicated.
 3. Design Uncoated-Steel Thickness: As indicated.
 4. Span Condition: As indicated.
 5. Side Laps: Overlapped.

2.4 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Flat Sump Plates: Single-piece steel sheet, 0.0747-inch-thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Recessed Sump Pans: Single-piece steel sheet, 0.0747-inch-thick, of same material and finish as deck, with 3-inch-wide flanges and recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- K. Galvanizing Repair Paint: ASTM A780/A780M.
- L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

- I. Mechanical fasteners may be used in lieu of welding to fasten deck when approved by the Engineer of Record. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
 1. Weld Diameter: 5/8-inch, nominal.
 2. Weld Spacing: Space and locate welds as indicated.
- B. Side-Lap and Perimeter Edge Fastening: As indicated.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.
 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.
 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes shop fabricated metal items.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
1. Aluminum Association (AA)
 2. American Architectural Manufacturers Association (AAMA)
 3. authority having jurisdiction (AHJ)
 4. American Iron and Steel Institute (AISI)
 5. American National Standards Institute (ANSI)
 6. American Society for Testing and Materials (ASTM)
 7. American Welding Society (AWS)
 8. Federal Specifications and Standards (FS)
 9. Green Seal (GC)
 10. International Building Code (IBC)
 11. International Code Council (ICC)
 12. National Association of Architectural Metal Manufacturers (NAAMM)
 13. National Ornamental and Miscellaneous Metals Association (NOMMA)
 14. Society for Protective Coatings (SSPC)
 15. Volatile organic compound (VOC)
- B. Reference Standards:
1. American Welding Society (AWS) D1.1, Structural Welding Code – Steel.
 2. AWS D1.6, Structural Welding Code – Stainless Steel.
 3. AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 4. American Society for Testing and Materials (ASTM).
 5. American National Standards Institute (ANSI).
 6. Federal Specifications and Standards (FS) DOD-P-21035B, Paint, High Zinc Dust Content, Galvanizing Repair.
 7. FS RR-G-1602D, Metal Grating other than Bar Type.
 8. NAAMM MBG 532, Metal Bar Grating Manual.
 9. National Ornamental and Miscellaneous Metals Association (NOMMA) Guideline 1, Joint Finishes.
 10. Society for Protective Coatings (SSPC) Steel Structures Painting Manual.

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept metal fabrications on site in labeled shipments. Inspect for damage.
- B. Miscellaneous metal fabrications shall be delivered to the site prime or special painted / coated, except as otherwise specified, and marked with a piece number.
- C. Miscellaneous metal fabrications and fasteners at the site shall be stored off the ground and stored/handled in such a manner as to prevent soiling, corrosion, and/or damage.

PART 2 PRODUCTS

2.1 MATERIALS - METALS

- A. Steel:
 - 1. Steel Sections: ASTM A36/A36M.
 - 2. Steel Plate: ASTM A36/A36M
 - 3. Hollow Structural Sections: ASTM A500, Grade B
 - 4. Steel Pipe: ASTM A53/A53M, Grade B Schedule 40.
 - 5. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.
 - 6. Raised pattern (Checkered) Floor Plate: ASTM A786.
 - 7. Bolts: ASTM A307; Grade A or B.
 - 8. Nuts: ASTM A563 heavy hex type.
 - 9. Washers: ASTM F436; Type 1.
 - 10. Welding Materials: AWS D1.1; type required for materials being welded.
 - 11. Shop Primer: SSPC Paint 15, Type 1, red oxide.
 - 12. Touch-up Primer: Match shop primer.
- B. Stainless Steel:
 - 1. Plate, Sheet and Strip: ASTM A167; Type 304.
 - 2. Bolts, Nuts, and Washers: ASTM A354.
 - 3. Welding Materials: AWS D1.6; type required for materials being welded.

2.2 LINTELS

- A. Lintels: Steel sections, size, and configuration as indicated on Drawings, length to allow 8 inches minimum bearing on both sides of opening.
 - 1. Exterior Locations: Galvanized.
 - 2. Interior Locations: Prime paint, one coat.

2.3 LEDGE AND SHELF ANGLES

- A. Ledge and Shelf Angles Not Attached to Structural Framing: For support of metal decking, joists, masonry; galvanized.

2.4 BOLLARDS

- A. Bollards: Steel pipe, concrete filled, crowned cap, 6 inches diameter, length as indicated on Drawings; prime paint, 1 coat
- B. Concrete Fill: 3,000 psi as specified in Section 03 30 00 - Cast-in-place Concrete.
- C. Base Connection: As indicated on Drawings.

2.5 LADDERS

- A. Ladder: ANSI A14.3, Steel welded construction:
 - 1. Side Rails: 3/8 inches by 2 inches side rails spaced at 16 inches clear minimum.
 - 2. Rungs: 1-inch diameter solid rod spaced uniform throughout the length of the ladder; 12 inches on center maximum.
 - 3. Mounting: Space rungs 7 inches clear from wall surface; with steel mounting brackets and attachments.
 - 4. Finish: Galvanized.

2.6 STRUCTURAL SUPPORTS

- A. Toilet Partition Suspension Members: Steel Channel or Angle sections; prime paint, 1 coat.

2.7 MECHANICAL ANCHORS

- A. Size and diameter indicated.
- B. Manufacturers:
 - 1. Hilti, "Kwik Bolt 3".
 - 2. Simpson Strong-Tie, "Strong-Bolt".

2.8 ADHESIVE ANCHORS

- A. Size and diameter indicated.
- B. Manufacturers:
 - 1. Hilti, "HIT HY150-SD".

2.9 DROP-IN ANCHORS

- A. Size and diameter indicated.
- B. Manufacturers:
 - 1. Hilti, "HDI Drop-In Anchor".
 - 2. Simpson Strong-Tie, "Drop-In".

2.10 STEEL BAR GRATING:

- A. Bearing Bars:
 - 1. Size and coating shall be as shown on the Drawings.
 - 2. Spacing: 1-3/16 inches on center.
 - 3. Surface: Smooth.
- B. Crossbars
 - 1. Spacing: 4 inches on center.
 - 2. Shape: Round, hexagonal, or square twisted.
 - 3. Crossbars shall be at right angles to bearing bars.
 - 4. Crossbars shall be pressure welded to bearing bars.
- C. The tops of all bars shall be flush.
- D. Provide edge bands of the same size as the bearing bars.
- E. Provide checkered plate nosings of 1¼-inch to 1½-inch width/face at treads and landing traffic edges.

2.11 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.

2.12 FACTORY APPLIED FINISHES – STEEL

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime paint items with 1 coat except where galvanizing is specified.
- D. Galvanizing for Fasteners, Connectors, and Anchors:
 - 1. Hot-dipped Galvanizing: ASTM A153/A153M.
 - 2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.
- E. Zinc for Hot-dip Galvanizing: ASTM B6.
- F. Zinc Compound for Field Repair of Hot-dip Galvanized Surfaces: FS DOD-P-21035B, Z.R.C. Cold Galvanizing Compound, by Z.R.C. World Wide.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required to meet AWS preparation requirements.
- B. Supply steel items required to be cast into concrete embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Make provisions for erection stresses. Install temporary bracing to maintain alignment, until permanent bracing and attachments are installed.
- C. Field weld components indicated on Drawings
- D. Perform field welding in accordance with AWS D1.1.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. Steel Bar Grating Installation Requirements:
 - 1. Install level and rattle free.
 - 2. Bearing bars shall bear on supports with 1-inch minimum bearing.
 - 3. Crossbars shall be on the topside.
 - 4. Notching of bearing bars shall not be permitted.
 - 5. Attach to supports, except at trench and sump angles, with 2 grating clamps per panel per support.
- G. Safety Grating Installation Requirements:
 - 1. Install level and rattle free.
 - 2. Sections / panels shall bear on supports with 1½-inch minimum bearing.
 - 3. Install with ¼-inch maximum gap between sections.
 - 4. Attach to supports with 2 hold-down clips per section / panel per support.
- H. Filler and/or shim plates shall be furnished and installed by the Contractor to provide alignment of members where required due to mill and/or fabrication tolerances.
- I. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

3.4 FIELD QUALITY CONTROL

- A. Miscellaneous metal fabrications and fasteners shall be inspected after installation to meet requirements in the Drawings and this Section.
- B. Inspection of welding shall be in accordance with AWS and special inspection requirements of ICC IBC with all welds visually inspected.

- C. Acceptance of welding inspection results shall be in accordance with of AWS.
- D. Acceptance of welding test results shall be in accordance with of AWS.

3.5 REPAIR AND CLEANING

- A. Abraded and scarred areas and connections on painted surfaces exposed to view shall be repaired per manufacturer's written instructions with matching field-applied repair coatings and with a minimum dry film thickness equal to that previously applied to the steel.
- B. Abraded and scarred areas on galvanized surfaces shall be repaired with cold galvanizing compound in accordance with ASTM A780 with a minimum dry film thickness of 8 mils.
- C. Wet storage stains on stainless and galvanized steel shall be removed after installation.
- D. Abraded and scarred areas on fusion-bonded epoxy-coated surfaces shall be repaired with patching compound in accordance with the manufacturer's written instructions and specifications with a minimum dry film thickness of 10 mils.

3.6 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
05 50 00-01	Product data for purchased items and products		2 weeks prior to fabrication or purchase
05 50 00-02	Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.		2 weeks prior to fabrication or purchase

END OF SECTION

SECTION 05 51 50

ROOF ACCESS WALKWAYS AND LADDERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aluminum access walkways and ladders.

1.2 RELATED SECTIONS

- A. Section 05500 – Metal Fabrications: Fasteners and installation requirements used to attach ladders to structure.

1.3 REFERENCES

- A. AA – Aluminum Association.
- B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. OSHA 1910.27 – Fixed Ladders.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product.
- C. Shop Drawings:
 - 1. Detail fabrication and erection of each ladder and walkway platform indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.
 - 2. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. Provide reaction loads for each hanger and bracket.
- D. Qualification Data:

1. Refer to Quality Assurance provisions for submittal requirements evidencing experience, certifications and resources.
- E. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors.
- F. Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, represent actual product color.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project.
 1. Record of successful in-service performance.
 2. Sufficient production capacity to produce required units.
 3. Professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.
- B. Installer Qualifications: Competent and experienced firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.
- C. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurement before fabrication.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, indicate established dimensions on shop drawing submittal and proceed with fabrication.

1.8 WARRANTY

- A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.
 1. Defects in materials and workmanship.
 2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third-party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.

3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective ladder.
- B. Manufacturer shall be notified immediately of defective products and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

1.9 EXTRA MATERIALS

- A. Furnish touchup kit for each type and color of paint finish provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: O'Keeffe's, Inc.; 100 N Hill Drive, Suite 12, Brisbane, CA 94005. Toll Free Tel: (888) 653-3333. Tel: (415) 824-4900. Fax: (415) 824-5900. Email: info@okeeffes.com. Web: <http://www.okeeffes.com>.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 APPLICATIONS/SCOPE

- A. Fixed Access Ladder and walkway:
 1. Standard Duty Channel Rail.
 - a. Model 500 as manufactured by O'Keeffe's Inc.
 2. Heavy Duty Tubular Rail.
 - a. Model 501 as manufactured by O'Keeffe's Inc.
 3. Tubular Rail Low Parapet Access Ladder with Roofover Rail Extension.
 - a. Model 502 as manufactured by O'Keeffe's Inc.
 4. Tubular Rail Low Parapet Access Ladder with Platform and Return.
 - a. Model 503 as manufactured by O'Keeffe's Inc.
 5. Tubular Rail Low Parapet Access Ladder with Platform.
 - a. Model 503A as manufactured by O'Keeffe's Inc.
 6. Tubular Rail Low Parapet Access Ladder with Walk-through Rail as shown on the drawings.
 - a. As manufactured by O'Keeffe's Inc.

2.3 FINISHES

- A. Clear Anodic Finish: AA-M10C22A41 Mechanical finish as fabricated. Architectural Class I, clear coating 0.018 mm or thicker.

2.4 MATERIALS

- A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.
- B. Aluminum Extrusions: Alloy 6063-T6 to comply with ASTM B221.

2.5 FABRICATION

- A. Rungs: Not less than 1-1/4 inches (32 mm) in section and 18-3/8 inches (467mm) long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
 - 1. Rungs shall withstand a 1,500-pound (454 kg) load without deformation or failure.
- B. Channel Side Rails: Not less than 1/8-inch (3 mm) wall thickness by 3 inches (76 mm) wide.
- C. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8-inch (3 mm) wall thickness by 3 inches (76 mm) wide. Construction shall be self-locking stainless-steel fasteners, full penetration TIG welds and clean, smooth and burr-free surfaces.
- D. Walk-Through Rail and Roof Rail Extension: Not less than 3 feet 6 inches (1067 mm) above the landing and shall be fitted with deeply serrated, square, tubular grab rails.
- E. Landing Platform: 1-1/2 inches (38 mm) or greater diameter, tubular aluminum guardrails and decks of serrated aluminum treads.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.
- B. Do not begin installation until supporting structure is complete and ladder installation will not interfere with supporting structure work.
- C. If supporting structure is the responsibility of another installer, notify Architect of unsatisfactory supporting work before proceeding.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.

3.3 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies treated and non-treated lumber, plywood, and associated rough hardware.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
1. American National Standards Institute (ANSI)
 2. American Wood Preservers' Association (AWPA)
 3. American Society of Testing and Materials (ASTM)
 4. U.S. Department of Commerce National Institute of Standards and Technology (DOC)
 5. International Building Code (IBC)
 6. National Fire Protection Association (NFPA)
 7. Southern Pine Inspection Bureau (SPIB)
 8. Underwriters Laboratories Inc. (UL)
 9. West Coast Lumber Inspection Bureau (WCLIB)
 10. Western Wood Products Association (WWPA)
- B. References Standards:
1. American National Standards Institute (ANSI) A208.1, Mat-formed Wood Particleboard.
 2. American Wood Preservers' Association (AWPA) C1, All Timber Products – Preservative Treatment by Pressure Process.
 3. AWPA C20, Structural Lumber – Fire-retardant Treatment by Pressure Processes.
 4. American Society of Testing and Materials (ASTM) E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 5. Engineered Wood Association (EWA) Technical Bulletin Number TB-200
 6. Forest Stewardship Council (FSC) Guidelines, Forest Stewardship Council Guidelines.
 7. National Fire Protection Association (NFPA) 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
 8. Redwood Inspection Service (RIS), Standard Specifications for Grades of California Redwood Lumber.
 9. Southern Pine Inspection Bureau (SPIB), Standard Grading Rules for Southern Pine Lumber.
 10. Underwriters Laboratories Inc. (UL) 723, Tests for Surface Burning Characteristics of Building Materials.
 11. U.S. Department of Commerce National Institute of Standards and Technology (DOC) PS1, Construction and Industrial Plywood.

12. DOC PS2, Performance Standard for Wood-Based Structural-Use Panels.
13. DOC PS20, American Softwood Lumber Standard.
14. West Coast Lumber Inspection Bureau (WCLIB), Standard Grading Rules for West Coast Lumber.
15. Western Wood Products Association (WWPA) G-5, Western Lumber Grading Rules.

1.3 STORAGE AND HANDLING

- A. Protect materials from the following:
 1. Dirt, oil, and other contaminants.
 2. Increase in moisture content. (Provide waterproof covers for wood products during shipment.)
- B. Stack lumber to provide air circulation within and around wood, sticker between each course.
- C. Store materials off the ground and protect from the weather.
- D. Move products to roof level in quantities needed for immediate use only. Do not store products on roof.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with the following:
 1. Lumber Grading Agency: Identify each piece of lumber with grade mark of a recognized association or independent inspection agency which is certified by American Lumber Standards Committee's Board of Review to grade species used.
- B. Surface Burning Characteristics:
 1. Fire Retardant Treated Materials: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- C. Apply label from agency approved by authority having jurisdiction to identify each preservative treated and fire-retardant treated material.

1.5 JOB CONDITIONS

- A. Install materials during dry weather only.

1.6 SEQUENCING

- A. Sequence Work so that installation of rough carpentry immediately precedes installation of roofing and sheet metals.

PART 2 PRODUCTS

2.1 LUMBER

- A. Material: Southern Yellow Pine, S4S, No. 2KD Grade.
- B. Maximum Lengths: 10 feet.
- C. Maximum Moisture Content: 19 percent.

2.2 PLYWOOD

- A. Material: APA B-C.
- B. Maximum Moisture Content: 18 percent.

2.3 ROUGH HARDWARE

- A. Wood Screws (for Wood-to-Wood Attachment): Galvanized (hot-dipped) or 300 series stainless steel, phillips or square socket, bugle head or equivalent type that does not require countersinking to produce flush fit. If size is not identified on Drawings, furnish minimum #10. If length is not identified on Drawings, furnish length needed to penetrate lumber substrate not less than 1 inch and completely penetrate plywood substrate.
- B. Concrete Screws (for Wood-to-Concrete Attachment): ¼-inch diameter screw specifically designed for use in concrete, equal to Buildex's "Tapcon," length recommended by manufacturer for intended use.
- C. Coated Self-Drilling Screws (for Wood-to-Metal Attachment): Minimum #12 coated self-drilling, self-tapping screws matching type and finish of screw used for securement of cover board. Furnish length needed to penetrate metal substrate not less than 1/2 inch. Equip each screw with minimum 5/8-inch OD galvanized (hot-dipped) washer.
- D. Other Fasteners:
 - 1. Furnish other fasteners needed for Work which are appropriate for substrate and component being fastened; furnish galvanized (hot-dipped) or 300 series stainless steel; type and length appropriate for intended use.
 - 2. Nails are not to be employed unless prior approval is obtained from Owner or specifically called for on Drawings. If nails are approved or called for on Drawings, provide galvanized (double hot-dipped), common nails, ring-shank, length as needed to penetrate substrate not less than 1-1/2 inches or, if substrate is less than 1-1/2 inches thick, full thickness of substrate.

2.4 TREATED LUMBER AND PLYWOOD

- A. Moisture Content: Provide lumber with the following moisture content at time of shipment:
 - 1. Lumber 1 inch and 1-1/4-inch nominal thickness: 15% maximum.
 - 2. Lumber 1-1/2 inches to 2 inches thickness: 18% maximum.

3. Lumber over 2 inches but not over 4 inches: 19% maximum.
 4. Lumber over 4 inches: 20% maximum.
- B. Plywood: Softwood plywood, Grade, Exterior Type, B-C Veneer Grade, identified with APA grade-trademark and conforming to USPS PS 1. Construct from species that can be pressure treated.
- C. Plywood Backing Panels: For mounting electrical or telephone equipment, provide FRT plywood panels with grade designation, APA C-D PLUGGED EXPOSURE 1, in thickness indicated, or, if not otherwise indicated, not less than ¾ inch nominal.

2.5 WOOD PRESERVATIVE-TREATED MATERIALS

- A. General: Where lumber or plywood is indicated on the drawings as preservative treated, pressure treated, or exterior treated, comply with applicable requirements of AWWA C2 (lumber) and AWWA C9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
1. Do not use chemicals containing chromium or arsenic, or any other "CCA", creosote, or asphalt-treated materials.
 2. For exposed items indicated to receive stained finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- B. Pressure treat aboveground items with "ACQ" preservatives as directed by manufacturer. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively. Treat indicated items and the following:
1. Wood cants, nailers, parapet copings, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
- C. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWWA M4 to cut surfaces. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.6 FIRE RETARDANT TREATED WOOD

- A. Fire Retardant Treatment: Pressure treatment, AWWA C20 for lumber and AWWA C27 for plywood, Interior Type, chemically treated and pressure impregnated.
- B. Moisture Content after Treatment:
1. Lumber: Maximum 19 percent.
 2. Structural Panels: Maximum 15 percent.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Pre-drill components being fastened before installing fasteners. Countersink wood components as needed to provide flush attachment.
- B. Install plywood so that joints between abutting panels are positioned over continuous, solid bearing.
- C. Install materials straight, in true alignment, and free of warp and gaps between abutting members.
- D. Fasten components rigidly in place; draw fasteners tight.
- E. Do not use nails to fasten wood components unless prior approval is obtained from A/E or specifically called for on Drawings.
- F. If Drawings do not describe spacing of fasteners securing lumber, space fasteners at maximum 16-inch centers when securing wood-to-wood and at maximum 16-inch centers when securing wood-to-masonry.
 - 1. For 2 x 4 members, stagger-space fasteners along two parallel rows.
 - 2. For 2 x 6 and larger members, fasten along two parallel rows with fasteners installed in each row at specified centers.
- G. Form 1/8-inch-wide joints at abutting plywood panels over solid bearing.
- H. If Drawings do not describe spacing of fasteners securing plywood, space fasteners as follows:
 - 1. One fastener in each corner of each piece and at maximum 6-inch centers along perimeter edges between corner fasteners.
 - 2. When pieces are wider or longer than 24 inches, fasten field area of each piece at maximum 12-inch centers along lines not more than 24 inches apart.
 - 3. Anchor all plywood and lumber per above requirements for spacing, type, and size of fasteners, or per requirements of factory mutual I-90 for wind uplift resistance, whichever is stricter.

3.2 PROTECTION OF WORK

- A. Protect installed rough carpentry from moisture (rain and condensation) until roofing and sheet metal systems are installed. Do not leave wood components exposed overnight or during inclement weather.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
06 10 53-01	Product Data: Submit technical data on wood preservative and fire-retardant treatment materials and application instructions.		Per construction schedule

END OF SECTION

SECTION 06 41 00

ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate cabinets.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for items installed in architectural woodwork.
- C. Samples for Verification: For the following:
 - 1. Plastic-laminate-clad panel products, 8 by 10 inches for each type, color, pattern, and surface finish, and substrate.
 - 2. Exposed cabinet hardware and accessories, one unit for each type.
- D. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. Both the company and the installers must have at least three years' experience.
- B. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork
- D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.
 - 1. Provide AWI certification labels or compliance certificate indicating that woodwork complies with requirements of grades specified.
- E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate

measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 1. Medium-Density Fiberboard: ANSI A208.2, Grade MD.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 - a. Formica Corporation.
 - b. Nevamar Company, LLC; Decorative Products Div.
 - c. Wilsonart International; Div. of Premark International, Inc.
- D. Adhesive for Bonding Plastic Laminate: Resorcinol.
 1. Adhesive for Bonding Edges: Hot-melt adhesive.

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to authorities having jurisdiction to produce products with fire-test-response characteristics specified.
 1. Do not use treated material that does not comply with requirements of referenced woodworking standard or that is warped, discolored, or otherwise defective.

2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with AWPAC20 (lumber) and AWPAC27 (plywood), for woodwork items indicated as fire-retardant treated. Use the following treatment type:
1. Interior Type A: Low-hygroscopic formulation.
 2. Mill lumber after treatment, within limits set for wood removal that does not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
 3. Kiln-dry material before and after treatment to levels required for untreated material.
- C. Fire-Retardant-Treated Lumber and Plywood by Non-pressure Process: Apply nontoxic, water-soluble, fire-retardant treatment by dip, spray, roller, curtain coating, vacuum chamber, or soaking to achieve flame-spread rating of 25 or less and smoke-developed rating of 450 or less per ASTM E 84.
- D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread rating of 25 or less and smoke-developed rating of 200 or less per ASTM E 84.
1. Product: Subject to compliance with requirements, provide "Medite FR" by Sierra Pine Ltd; Medite Div.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Door Hardware (Scheduled by Describing Products)."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.
- C. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- D. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- E. Drawer Slides: BHMA A156.9, B05091.
1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated steel ball-bearing slides.
- F. Grommets for Cable Passage through Countertops: 1-1/4-inch black, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Product: Subject to compliance with requirements, provide "OG series" by Doug Mockett & Company, Inc.

- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
- H. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 INSTALLATION MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.5 FABRICATION, GENERAL

- A. Fabricate woodwork to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- C. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.

2.6 PLASTIC-LAMINATE CABINETS

- A. Quality Standard: Comply with AWI Section 400 requirements for laminate cabinets.
- B. Grade: Premium.
- C. AWI Type of Cabinet Construction: As indicated on Architectural drawings.
- D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate, 0.028-inch minimum thickness.
- E. AWI Type of Cabinet Construction: Flush overlay
- F. WI Construction Style: Style Frameless
- G. WI Door and Drawer Front Style: Flush.

- H. Materials for Semi-exposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, 0.028-inch minimum.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber
 - 3. Drawer Bottoms: Hardwood Plywood.
- I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Provide Architect's selections from laminate manufacturer's full range of colors and finishes.

PART 3 EXECUTION

3.1 PREPARATION

- A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back priming.

3.2 INSTALLATION

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified in Part 2 of this Section for type of woodwork involved.
- B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces and repair damaged finish at cuts.
- D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with recommendations of chemical treatment manufacturer, including those for adhesives used to install woodwork.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Delete paragraph and subparagraphs below if not applicable or considered necessary.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
 - 1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base, if finished.
 - 2. Install wall railings on indicated metal brackets securely fastened to wall framing.

3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 2. Maintain veneer sequence matching of cabinets with transparent finish.
 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips, No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish, toggle bolts through metal backing or metal framing behind wall finish.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

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SECTION 06 65 10

QUARTZ SURFACING FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Quartz countertops.
 - 2. Quartz window stools.
 - 3. Setting materials and accessories.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - A108.5: Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar.
 - A118.4: Latex-Portland Cement Mortar.
- B. ASTM International (ASTM):
 - C 97: Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
 - C 99: Standard Test Methods for Modulus for Rupture of Dimension Stone.
 - C 170: Standard Test Methods for Compressive Strength of Dimension Stone.
 - C 241: Standard Test Methods for Abrasion Resistance of Stone Subjected to Foot Traffic.
 - C 482: Standard Test Methods for Bond Strength of Ceramic Tile to Portland Cement.
 - C 484: Standard Test Methods for Thermal Shock Resistance of Glazed Ceramic Tile.
 - C 531: Standard Test Methods for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - C 648: Standard Test Method for Breaking Strength of Ceramic Tile.
 - C 650: Standard Test Methods for Resistance of Ceramic Tile to Chemical Substances.
 - C 672/C 672M: Standard Test Methods for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
 - C880: Standard Test Methods for Flexural Strength of Dimension Stone.
 - C 1026: Standard Test Methods for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling.
 - C 1028: Standard Test Methods for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
 - E 84: Standard Test Methods for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Manufacturer's product literature.
- B. Shop Drawings: Include layout, dimensions, materials, finishes, cutouts and attachments.
- C. Samples: 3 x 3 inch quartz samples showing available colors.

1.4 QUALITY ASSURANCE

- A. Fabricator and Installer Qualifications: Minimum 2 years documented experience in work of this Section – both the company and the installers.

1.5 WARRANTY

- A. Provide manufacturer's 10 year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Contract Documents are based on products by Silestone, Inc.
- B. Approved Manufacturer:
 - 1. Silestone

2.2 MATERIALS

- A. Quartz Sheet:
 - 1. Product: Silestone.
 - 2. Composition: Quartz aggregate, resin and color pigments formed into flat slabs.
 - 3. Anti-microbial Protection: Microban by Microban International, Inc. integral to sheet.
 - 4. Color: To be selected from manufacturer's full color range.
 - 5. Thickness: 3/4"
 - 6. Physical Characteristics:
 - a. Static Coefficient of Friction: 1.02 dry, 0.51 wet, tested to ASTM C 1028.
 - b. Water Absorption: Maximum 0.03 percent, tested to ASTM C 97.
 - c. Compressive Strength: Minimum 29,000 psi, tested to ASTM C 170.
 - d. Bond Strength: Minimum 210 psi, tested to ASTM C 482.
 - e. Modulus of Rupture: Minimum 6300 psi, tested to ASTM C 99.
 - f. Flexural Strength: Minimum 5800 psi, tested to ASTM C 880.
 - g. Breaking Strength: Minimum 480 lbf, tested to ASTM C 648.
 - h. Stain Resistance: Not affected by 10 percent hydrochloric acid or 10 percent KOH, tested to ASTM C 650.
 - i. Thermal Shock Resistance: Pass 5 cycles, tested to ASTM C 484.
 - j. Abrasive Index: 65-Ha = 25, tested to ASTM C 241.

- k. Thermal Expansion: 1.670×10^{-5} in/in/°F, tested to ASTM C 531.
- l. Deicing Resistance: Rating of 0, tested to ASTM C 672/C 672M.
- m. Freeze/Thaw Resistance: 0 tiles at 15 cycles, tested to ASTM C 1026.
- n. Flame Spread Rating: Class 1, tested to ASTM E 84.

2.3 ACCESSORIES

- A. Adhesive: Type recommended by quartz manufacturer.
- B. Joint Sealer:
 - 1. Latisil Tile and Stone Sealant by Laticrete International, Inc.
 - 2. Color: To be selected from manufacturer's full color range.

2.4 FABRICATION

- A. Cut quartz panels accurately to required shapes and dimensions.
- B. Radius exposed edges.
- C. Fabricate with hairline joints.
- D. Cut holes for sinks and faucets.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive fabrications; remove loose and foreign matter that could interfere with adhesion.

3.2 INSTALLATION

- A. Install fabrications in accordance with manufacturer's instructions and approved shop drawings.
- B. Set plumb and level. Align adjacent pieces in same plane.
- C. Install with hairline joints.
- D. Fill joints between fabrications and adjacent construction with joint sealer; finish smooth and flush.

3.3 INSTALLATION TOLERANCES

- A. Maximum variation from level and plumb; 1/8 inch in 10 feet, noncumulative.
- B. Maximum variation in plane between adjacent pieces at joint; plus or minus 1/16 inch.

3.4 CLEANING

- A. Clean fabrications in accordance with manufacturer's instructions.

3.5 PROTECTION

- A. Protect installed fabrications with non-staining sheet coverings.

END OF SECTION

SECTION 07 21 13
BOARD INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes rigid board insulation for exterior wall construction and roof construction.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. Green Seal (GS)
 - 4. International Building Code (IBC)
 - 5. National Fire Protection Association (NFPA)
 - 6. South Coast Air Quality Management District (SCAQMD)
 - 7. Underwriters Laboratories Inc. (UL)
- B. References Standards:
 - 1. ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 2. ASTM D2842, Standard Test Method for Water Absorption of Rigid Cellular Plastics.
 - 3. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 4. Green Seal (GS) 36, Aerosol Adhesives.
 - 5. National Fire Protection Association (NFPA) 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - 6. Underwriters Laboratories Inc. (UL) 723, Tests for Surface Burning Characteristics of Building Materials.

1.3 SYSTEM DESCRIPTION

- A. Materials of This Section: Provide continuity of thermal barrier at building enclosure elements in conjunction with thermal insulating materials in this section.

1.4 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.5 QUALITY ASSURANCE

- A. Insulation Installed in Concealed Locations Surface Burning Characteristics:
 - 1. Foam Plastic Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- B. Apply label from agency approved by authority having jurisdiction (AHJ) to identify each foam plastic insulation board.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.1 BOARD INSULATION

- A. Manufacturers and Products:
 - 1. Roof Insulation: Johns Manville: Energy 3 Foil Face.
 - 2. Wall Insulation: Dow Chemical Company: Thermax (ci) Exterior Insulation.

2.2 COMPONENTS

- A. Roof: Polyisocyanurate Insulation: ASTM C1289, rigid board, conforming to the following:
 - 1. Board Size: 4 feet x 4 feet, or 4 feet x 8 feet.
 - 2. Board Thickness: (2) staggered layers at 2 inches thick each, for a total thickness of 4 inches. Foil facing shall be taped on the top layer. Bottom layer does not require foil facer.
 - 3. Facing: Foil-faced (required for top layer only).
 - 4. Compressive Strength: Minimum 25 psi.
 - 5. Thermal Resistance: R of 6 per inch.
 - 6. Board Edges: Square or Ship lapped.
 - 7. Water Absorption: In accordance with ASTM D2842 less than 1 percent by volume maximum.
- B. Wall: Polyisocyanurate Insulation: ASTM C1289, rigid board, glass fiber reinforced type. Dow Corning Thermax (ci) Exterior Insulation, foil-faced, conforming to the following:
 - 1. Board Size: 4 feet x 8 feet, or 4 feet x 12 feet.
 - 2. Board Thickness: 2 inches.
 - 3. Facing: Foil-faced.
 - 4. Compressive Strength: Minimum 20 psi.
 - 5. Thermal Resistance: R of 6.5 per inch.
 - 6. Board Edges: Ship lapped
 - 7. Water Absorption: In accordance with ASTM D2842 less than 1 percent by volume maximum.

2.3 ACCESSORIES

- A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2-inch wide for standard sheathing joints.
- B. Tape: Bright aluminum self-adhering type, mesh reinforced, 6-inch wide where indicated on Drawings to wrap around corners.
- C. Insulation Fasteners: Impaling clips as mechanically fastened to surface to receive board insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify substrate, adjacent materials, and insulation boards are dry and ready to receive insulation.
- B. Verify substrate surface is flat.

3.2 INSTALLATION – EXTERIOR WALLS

- A. Install boards over face of gypsum sheathing.
- B. Place boards in method to maximize contact bedding. Stagger end joints. Butt edges and ends tight to adjacent board and to protrusions.
- C. Cut and fit insulation tight to protrusions or interruptions to insulation plane.
- D. Tape all insulation board joints.
- E. Install fasteners and fastener sizes as directed in writing by the insulation manufacturer.

3.3 INSTALLATION – ROOF

- A. Install boards over top of metal decking.
- B. Place boards in method to maximize contact bedding. Stagger end joints. Butt edges and ends tight to adjacent board and to protrusions. Stagger layers.
- C. Cut and fit insulation tight to protrusions or interruptions to insulation plane.
- D. Tape all insulation board joints.
- E. Install fasteners and fastener sizes as directed in writing by the insulation manufacturer.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not permit damage to insulation prior to covering.

3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
07 21 13-01	Product Data: Submit manufacturer's product data on product characteristics and performance criteria.	X	Per construction schedule
07 21 13-02	Manufacturer's Installation Instructions: Submit special environmental conditions required for installation and installation techniques.	X	Per construction schedule
07 21 13-03	Material samples: Min. 6" square.	X	Per construction schedule
07 21 13-04	Manufacturer's Certificate: Certify that products meet or exceed specifications.	X	Per construction schedule

END OF SECTION

SECTION 07 21 16

BLANKET INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the requirements necessary to furnish and install:
 - 1. Blanket insulation in exterior wall construction.
 - 2. Mineral Wool Batt insulation for interior fire-rated partitions.
 - 3. Acoustic insulation for interior partitions.
 - 4. Insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof assembly.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Glass Fiber Insulation:
 - 1. Certainteed.
 - 2. Johns Manville.
 - 3. Knauf Fiber Glass.
 - 4. Owens Corning Fiberglas.
- B. Sound-batt insulation:
 - 1. Owens Corning.
- C. Mineral Fiber Insulation:
 - 1. Thermafiber, Inc.

2.2 MATERIALS

- A. Exterior Wall Insulation where indicated on Drawings: ASTM C 665; preformed glass or mineral fiber batt, Type I, without membrane, 8" thick.
- B. Interior sound insulation: 3 ½" thick sound attenuation batts for 3 5/8" stud walls; and 6" thick sound attenuation batts for 6" stud walls.
- C. Insulation for interior fire-rated partitions: 6" thick batts for 6" stud walls.
- D. Insulation Fasteners: Corrosion-resistant steel impale spindle and clip on corrosion-resistant flat metal base, self-adhering backing, length to suit insulation thickness, capable of securely and rigidly fastening insulation in place, as recommended by manufacturer.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify adjacent materials are clean, dry and ready to receive installation.
- B. Verify mechanical and electrical services within walls have been installed and tested.

3.2 INSTALLATION

- A. Install batt insulation in accordance with manufacturer's instructions.
- B. Install batt insulation and vapor retarder membrane (where specified) in walls and ceiling spaces without gaps or voids.
- C. Trim insulation neatly to fit spaces. Use batts free of damage.
- D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation to ensure a continuous seal. Leave no gaps or voids.
- E. Verify intended location of vapor retarder to ensure that condensation does not occur within insulation system.
- F. Use care to avoid damage and soiling face of insulation that will be exposed to view.
- G. No insulation will be allowed to be exposed to the interior environment of the facility. Verify that all insulation is concealed behind interior finish materials.

3.3 SCHEDULE

- A. Install insulation in metal stud exterior walls and exterior ceiling soffits where shown on the Drawings.

END OF SECTION

SECTION 07 42 13.13

METAL WALL PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concealed fastener metal wall panels, and liner panels as part of the assembly described in Section 2.1.

1.2 RELATED REQUIREMENTS

- A. American Society of Civil Engineers (ASCE):

- 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

- B. ASTM International (ASTM):

- 1. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - 4. ASTM A 792/A 792 M - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 5. ASTM B 209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - 6. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
 - 7. ASTM C 920 - Specification for Elastomeric Joint Sealants.
 - 8. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
 - 9. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
 - 10. ASTM E 283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
 - 11. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

- C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

- 1. Architectural Sheet Metal Manual.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide metal wall panel assemblies meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.
- B. Air Infiltration: When installed over Insulated Composite Backup Panels or Metal Liner Panels, maximum 0.06 cfm/sq. ft. (0.3 L/s per sq. m) per ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
- C. Water Penetration, Static Pressure: When installed over Insulated Composite Backup Panels or Metal Liner Panels, no uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 6.24 lbf/sq. ft. (299 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
- D. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

1.4 QUALITY ASSURANCE

- A. Manufacturer/Source: Provide metal wall panel and panel accessories from a single manufacturer.
- B. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum 10 years experience in manufacture of similar products in successful use in similar applications.
 - 1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
 - a. Product data, including certified independent test data indicating compliance with requirements.
 - b. Load span tables including evaluation of panel clip and panel side joint interaction.
 - c. Samples of each component.
 - d. Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.
 - e. Sample warranty.
 - 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
 - 3. Approved manufacturers must meet separate requirements of Submittals Article.
- C. Wall Systems Installer Qualifications: Experienced Installer with minimum of 5 years experience with successfully completed projects of a similar nature and scope.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's representative, and other trade contractors.

1. Coordinate building framing in relation to metal wall panel assembly.
2. Coordinate installation of building air and water barrier behind metal wall panel assembly.
3. Coordinate window, door and louver, and other openings and penetrations of metal wall panel assembly.

1.6 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets, for specified products.
 1. Include data indicating compliance with performance requirements.
- B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized Installer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale of 1-1/2-inch per foot (1:8) of all required trim and extrusions needed for a complete installation.
 1. Indicate points of supporting structure that must coordinate with metal wall panel assembly installation.
 2. Indicate details of fastening, including clip spacing, supported by load span tables that include an evaluation of clip and panel side joint interaction.
- C. Samples for Initial Selection: For each product specified. Provide representative color charts of manufacturer's full range of colors.
- D. Samples for Verification: Provide 12-inch (300 mm) section of panel(s) showing finishes. Provide 12-inch (300 mm) long pieces of trim pieces and other exposed components.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.
- B. Qualification Information: For Installer firm.
- C. Manufacturer's warranty: Submit sample warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal wall panel products during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.
 1. Deliver, unload, store, and erect metal wall panel products and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

1.10 WARRANTY

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials and workmanship within [two] years from date of Substantial Completion.
- B. Special Panel Finish Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall panels that display evidence of deterioration of finish within 20 years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Metal Liner Panel System: Section includes secondary metal subgirt framing for panel attachment and an interior sealed-joint metal liner panel that provides air, water and water vapor control.
- B. Metal Wall Panels over Multi-Component Framed Wall System: Single-skin concealed fastener metal wall panels applied as exterior rainscreen cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing" with exterior sheathing specified in Division 06 Section "Sheathing", an applied membrane that provides air, moisture, and water vapor control specified in Division 07 Section "Air Barriers", and insulation within the framing specified in Division 07 Section "Thermal Insulation". Metal wall panel installation specified in this Section includes mounting clips for panel attachment.
- C. Metal Wall Panels over Uninsulated Framed Screen Wall System: Single-skin concealed fastener metal wall panels applied as exterior barrier cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing". Metal wall panel installation specified in this Section includes secondary metal subgirt framing and mounting clips for panel attachment.

2.2 MANUFACTURERS

- A. Basis of Design: CENTRIA, Concept Series Metal Wall Panels. Provide basis of design product.
 - 1. CENTRIA Architectural Systems; Moon Township, PA 15108-2944. Tel: (800)759-7474. Tel: (412)299-8000. Fax: (412)299-8317. Email: info@CENTRIA.com. Web: www.CENTRIA.com.

2.3 PANEL MATERIALS

- A. Metallic-Coated Steel Face Sheet: Coil-coated, ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Class Z275), structural steel.
 - 2. Face Sheet: Minimum 0.024 inch/24 gage (0.60 mm) nominal uncoated thickness.
 - 3. Surface: Smooth.

2.4 CONCEALED FASTENER METAL WALL PANELS

- A. Metal Wall Panels, General: Factory-formed, concealed fastener panels with interconnecting side joints, fastened to supports with concealed fasteners, with factory-applied sealant in side laps when required to meet performance requirements.
- B. Three-rib Profile MWP#01:
 - 1. Basis of Design Product: CENTRIA, CS-260.
 - 2. Panel Coverage: 12 inches (305 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- C. Double-reveal profile with raised flat pan and rib MWP#02:
 - 1. Basis of Design Product: CENTRIA, CS-610.
 - 2. Panel Coverage: 16 inches (406 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- D. Reveal profile with raised flat pan and double-rib MWP#03:
 - 1. Basis of Design Product: CENTRIA, CS-612.
 - 2. Panel Coverage: 16 inches (406 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- E. Double-reveal profile with evenly-spaced raised flat pan between reveals MWP#04:
 - 1. Basis of Design Product: CENTRIA, CS-620.
 - 2. Panel Coverage: 16 inches (406 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- F. Exposed Coil-Coated Finish System:
 - 1. Fluoropolymer Three-Coat System: 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, and a 0.8 mil 70 percent PVDF fluoropolymer clear coat, AAMA 621.
 - a. Basis of Design: CENTRIA Duragard Plus.
- G. Color:
 - 1. Exterior Surface: As selected by Architect from manufacturer's standard colors.
 - 2. Interior Surface: As selected by Architect from manufacturer's standard colors.

2.5 LINER PANELS

- A. Metal Liner Panels, General: Factory-formed panels with interconnecting side joints, fastened to supports with fasteners.
 - 1. Zinc-Coated (Galvanized) Steel Sheet.
 - 2. Face Sheet: Minimum 0.024 inch/24 gage (0.60 mm) nominal uncoated thickness.
 - 3. Panel Sheet: Solid.

4. Surface: Smooth.

B. Metal liner panel MLP#01A:

1. Basis of Design Product: CENTRIA, L2.
2. Panel Coverage: 24 inches (610 mm).
3. Panel Height: 1-3/8 inches (35 mm).
4. Stiffening Beads: Two.

C. Exposed Coil-Coated Finish System:

1. Fluoropolymer Three-Coat System: 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, and a 0.8 mil 70 percent PVDF fluoropolymer clear coat, AAMA 621.
 - a. Basis of Design: CENTRIA Duragard Plus.

D. Color:

1. Interior Exposed Surface: As selected by Architect from manufacturer's standard colors..
2. Concealed Surface: Manufacturer's standard primer color.

2.6 METAL WALL PANEL ACCESSORIES

- A. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, lap tapes, and closure strips for a complete installation. Fabricate and install accessories in accordance with SMACNA Manual.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine metal wall panel substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.
- B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.
1. Maximum deviations acceptable:
 - a. 1/4-inch in 20 feet (6.4 mm in 6 m) vertically or horizontally from face plane of framing.
 - b. 1/2-inch (12.7 mm) across building elevation.
 - c. 1/8-inch in 5 feet (3.2 mm in 1.5 m).
- C. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of

acceptable framing members at recommended spacing to match installation requirements of metal wall panels.

- D. Air/Moisture Barriers: Confirm that work has been completed, inspected, and tested as required.
- E. Openings: Verify that window, door, louver and other penetrations match layout on shop drawings.
- F. Advise G.C., in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.
- G. Correct out of tolerance work and other deficient conditions prior to proceeding with insulated composite backup panel installation.

3.2 SECONDARY FRAMING INSTALLATION

- A. Secondary Metal Framing: Install secondary metal framing components to tolerances indicated, as shown on approved shop drawings. Install secondary metal framing and other metal panel supports per ASTM C 1007 and metal wall panel manufacturer's recommendations.

3.3 METAL WALL PANEL INSTALLATION

- A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place. Provide for thermal and structural movement
- B. Attach panels to metal framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
 - 1. Fasteners for Steel Wall Panels: Stainless-steel for exterior locations and locations exposed to moisture; carbon steel for interior use only.
 - 2. Fasten metal wall panels to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Install clips to supports with self-tapping fasteners.
 - 3. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
 - 4. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.
- C. Joint Sealers: Install joint sealants where indicated on approved shop drawings.

3.4 ACCESSORY INSTALLATION

- A. General: Install metal wall panel accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install related flashings and sheet metal trim per requirements of Division 07 Section "Sheet Metal Flashing and Trim."

2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, lap strips, flashings, sealants, fillers, closure strips, and similar items.
3. Comply with performance requirements and manufacturer's written installation instructions.
4. Provide concealed fasteners except where noted on approved shop drawings.
5. Set units true to line and level as indicated.

3.5 FIELD QUALITY CONTROL

- A. Correct deficiencies noted in manufacturer's report.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.
- B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION

SECTION 07 52 16

STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. SBS-modified bituminous membrane roofing.
- B. Cover board.
- C. Roof insulation.
- D. Vapor retarder.

1.2 RELATED SECTIONS

- A. Division 05 Section "Steel Decking" for steel roof deck.
- B. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, cants, curbs, and blocking.
- C. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter flashings.
- D. Division 22 Section "Storm Drainage Piping Specialties" for roof drains.

1.3 REFERENCES

- A. Roofing Terminology: Refer to the following publications for definitions of roofing work related terms in this Section:
 - 1. ASTM D 1079 "Standard Terminology Relating to Roofing and Waterproofing."
 - 2. Glossary of NRCA's "The NRCA Roofing and Waterproofing Manual."
 - 3. Roof Consultants Institute "Glossary of Building Envelope Terms."
- B. Sheet Metal Terminology and Techniques: SMACNA "Architectural Sheet Metal Manual."

1.4 DESIGN CRITERIA

- A. General: Installed roofing membrane system shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

- C. Installer shall comply with current code requirements based on authority having jurisdiction.
- D. Wind Uplift Performance: Roofing system shall be identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE 7.
- E. FMG Listing: Roofing membrane, base flashings, and component materials shall comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
 - 1. Roofing system shall comply with RoofNav #: 445524-48573-0
 - 2. Fire/Windstorm Classification: Class 1A-90
 - 3. Hail Resistance: SH.
- F. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's data sheets for each product to be provided.
- B. Detail Drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
 - 4. Insulation fastening and adhesive patterns.
- C. Verification Samples: Provide for each product specified.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- E. Maintenance Data: Refer to Johns Manville's latest published documents on www.JM.com.
- F. Guarantees: Provide manufacturer's current guarantee specimen.
- G. Prior to beginning the work of this section, roofing sub-contractor shall provide a copy of the final System Assembly Letter issued by Johns Manville Roofing Systems indicating that the products and system to be installed shall be eligible to receive the specified manufacturer's guarantee when installed by a certified JM contractor in accordance with our application requirements, inspected and approved by a JM Technical Representative.

- H. Prior to roofing system installation, roofing sub-contractor shall provide a copy of the Guarantee Application Confirmation document issued by Johns Manville Roofing Systems indicating that the project has been reviewed for eligibility to receive the specified guarantee and registered.
 - 1. "Jacobs shall be listed as the Specifier/Consultant of record in the appropriate fields on the Guarantee Application Confirmation.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive the specified manufacturer's guarantee.
- B. Manufacturer Qualifications: Qualified manufacturer that has UL listing and FMG approval for roofing system identical to that used for this Project.
- C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 329.
- D. Test Reports:
 - 1. Roof drain and leader test or submit plumber's verification.
- E. Source Limitations: Obtain all components from the single source roofing manufacturer guaranteeing the roofing system. All products used in the system shall be labeled by the single source roofing manufacturer issuing the guarantee.
- F. Provide evidence of CERTA training for any installer of torch-applied modified bitumen membrane. Copies of certifications are required prior to award and shall be maintained on the jobsite for inspection at any time.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.

1.9 GUARANTEE

- A. Provide manufacturer's system guarantee equal to Johns Manville's Peak Advantage No Dollar Limit Roofing System Guarantee.
 - 1. Single-Source special guarantee includes roofing plies, base flashings, liquid applied flashing, roofing membrane accessories, granule surfaced roofing membrane, roof insulation, fasteners, cover board, vapor retarder, walkway products, manufacturer's expansion joints, manufacturer's edge metal products, and other single-source components of roofing system marketed by the manufacturer.
 - 2. Guarantee Period: 20 years from date of Substantial Completion.
 - 3. Contractor is required to list "Jacobs" as the Specifier/Consultant of record in the appropriate fields ("Specifier Account") when applying for the manufacturer's warranty.
- B. Installer's Guarantee: Submit roofing Installer's guarantee, signed by Installer, covering Work of this Section, including all components of roofing system, for the following guarantee period:
 - 1. Guarantee Period: Two years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 SHEET MATERIALS

- A. Roofing Membrane Sheet: ASTM D 6163, Grade S, Type I, glass-fiber-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified. Basis of Design: DynaWeld Base.
- B. Roofing Membrane Cap Sheet: ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified. Basis of Design: DynaWeld Cap FR.

2.2 FLASHING SHEET MATERIALS

- A. Backer Sheet: ASTM D 6163, Grade S, Type I, glass-fiber-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified. Basis of Design: DynaWeld Base
- B. Flashing Sheet: ASTM D 6163, Grade G, Type I, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified. Basis of Design: DynaWeld Cap FR
- C. Liquid Applied Flashing: A liquid and fabric reinforced flashing system created with a stitch bonded polyester scrim and a two-component, moisture cured, elastomeric, liquid applied flashing material, consisting of an asphalt extended urethane base material and an activator. Basis of Design: PermaFlash System

2.3 AUXILIARY ROOFING

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with built-up roofing.
- B. Asphalt Primer: ASTM D 41. Basis of Design: Asphalt Primer
- C. Cold-Applied Flashing Adhesive: Roofing system manufacturer's asphalt-based, one-part, asphalt-based, trowel-grade mastic, cold-applied adhesive specially formulated for compatibility and use with flashing applications. Basis of Design: MBR Utility Cement
- D. Mastic Sealant: As required by Johns Manville.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing membrane components to substrate, tested by manufacturer for required pullout strength, and provided by the roofing system manufacturer. Basis of Design: UltraFast Fasteners and Plates
- F. Roofing Granules: Ceramic-coated roofing granules matching specified cap sheet, provided by roofing system manufacturer. Roofing Granules
- G. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.4 WALKWAYS

- A. Walkway Pads: Mineral-granule-surfaced, reinforced modified asphalt composition, slip-resisting pads, manufactured as a traffic pad for foot traffic provided by roofing system manufacturer, with a pad size of 32 inch x 32 inch. Basis of Design: DynaTred Walkway

2.5 COVER BOARD

- A. Gypsum Board: ASTM C 1177, Heavy duty coated glass-mat facer, water-resistant gypsum substrate for fully adhered roof applications, 1/2 inch (13 mm) thick. Basis of Design: JM DEXcell FA Glass Mat Roof Board

2.6 ROOF INSULATION

- A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 (20 psi), Basis of Design: ENRGY 3
 - 1. Provide insulation package with minimum R Value: R-25.
 - 2. Provide insulation package with minimum thickness: 4.2 inches.
 - 3. Provide insulation package in multiple layers.
 - 4. Minimum Long-Term Thermal Resistance (LTTR): 5.7 per inch.
 - a. Determined in accordance with CAN/ULC S770 at 75°F (24°C)

2.7 TAPERED INSULATION

- A. Tapered Insulation: ASTM C 1289, Type II, Class 1, Grade 2 (20 psi), provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), unless otherwise indicated. Basis of Design: Tapered ENRGY 3

2.8 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
- B. Provide factory preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated. Basis of Design: DiamondBack Pre-Cut Crickets DiamondBack Pre-Cut Miters Tapered Fesco Edge Strip
- C. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and furnished by roofing system manufacturer. Basis of Design: UltraFast Fasteners and Plates
- D. Urethane Adhesive: Manufacturer's two component polyurethane adhesive formulated to adhere insulation to substrate. Basis of Design: JM Two-Part Urethane Insulation Adhesive (UIA)
- E. Insulation Cant Strips: ASTM C 728, perlite insulation board. Basis of Design: FesCant Plus
- F. Wood Nailer Strips: Comply with requirements in Division 06 Section "Miscellaneous Rough Carpentry."

2.9 VAPOR RETARDER

- A. Polyethylene Vapor Retarder: ASTM D 4397, 10 mils (0.25 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
 - 1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
 - 2. Adhesive: Manufacturer's standard lap adhesive, FMG approved for vapor-retarder application.

2.10 EDGE METAL COMPONENTS

- A. Expansion Joints: Provide factory fabricated weatherproof, exterior covers for expansion joint openings consisting of flexible rubber membrane, supported by a closed cell foam to form flexible bellows, with two metal flanges, adhesively and mechanically combined to the bellows by a bifurcation process. Provide product from single-source roofing system supplier that is included in the No Dollar Limit guarantee. Basis of Design: Expand-O-Flash Expand-O-Gard

- B. Coping System: Manufacturer's factory fabricated coping consisting of a base piece and a snap-on cap. Provide product from single-source roofing system supplier that is included in the No Dollar Limit guarantee. Basis of Design: Presto-Lock Coping
- C. Fascia System: Manufacturer's factory fabricated fascia consisting of a base piece and a snap-on cover. Provide product from single-source roofing system supplier that is included in the No Dollar Limit guarantee. Basis of Design: Presto-Tite Fascia Presto-Tite Edge One Fascia
- D. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing and Trim."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with the requirements affecting performance of roofing system.
 - 1. General:
 - a. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 2. Steel Decks:
 - a. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
 - 3. Ensure general rigidity and proper slope for drainage.
 - 4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units more than 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
- B. Unacceptable panels should be brought to the attention of the General Contractor and Project Owner's Representative and shall be corrected prior to installation of roofing system.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and remove from substrate sharp projections, dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
- C. If applicable, prime surface of deck with asphalt primer at a rate recommended by roofing manufacturer and allow primer to dry.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 VAPOR-RETARDER INSTALLATION

- A. Install polyethylene-sheet vapor retarder as a loosely laid single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
 - 1. Seal side and end laps with tape or adhesive.
- B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
 - 1. Repair tears and voids in laps and lapped seams not completely sealed.
- C. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSULATION INSTALLATION

- A. Coordinate installation of roof system components so insulation and cover board are not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system manufacturer's written instructions for installation of roof insulation and cover board.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation boards with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch (6 mm) with like material.
- E. Install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- F. Trim surface of insulation boards where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- G. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- H. Loose Laid Insulation with Top Insulation Layer Mechanically Fastened: Loose lay insulation with staggered joints and secure top layer of insulation to deck using mechanical fasteners designed and sized for fastening specified board-type to deck type.
 - 1. Fasten top layer according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
 - 2. Fasten top layer to resist uplift pressure at corners, perimeter, and field of roof.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 COVER BOARD INSTALLATION

- A. Coordinate installing membrane roofing system components so cover board is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.
- C. Install cover board with long joints in a continuous straight line. Joints should be staggered between rows, abutting edges and ends per manufacturer's written instructions. Fill gaps exceeding 1/4 inch (6 mm) with cover board.
 - 1. Cut and fit cover board within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- D. Trim surface of cover board where necessary at roof drains so completed surface is flush and does not restrict flow of water.
 - 1. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- E. Adhered Cover Board: Adhere cover board to substrate as follows:
 - 1. Install in a two-part urethane adhesive according to roofing system manufacturer's instruction.
 - 2. Install to resist uplift pressure at corners, perimeter, and field of roof.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.6 ROOFING MEMBRANE INSTALLATION, GENERAL

- A. Install roofing membrane in accordance with roofing system manufacturer's written instructions, applicable recommendations of the roofing manufacturer and requirements in this Section.
- B. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.
- C. Where roof slope exceeds 1/2 inch per 12 inches (1:24), contact the membrane manufacturer for installation instructions regarding installation direction and back nailing.
- D. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is imminent.
 - 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation.
 - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 - 3. Remove and discard temporary seals before beginning work on adjoining roofing.
- E. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.7 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

- A. Install one modified bituminous roofing membrane sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, with the following installation method:
 - 1. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.
 - 2. Heat weld to substrate according to roofing system manufacturer's instruction.
- B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
 - 1. Repair tears and voids in laps and lapped seams not completely sealed.
 - 2. Apply roofing granules to cover exuded bead at laps while bead is hot.
- C. Install roofing membrane sheets so side and end laps shed water.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.8 FLASHING AND STRIPPING INSTALLATION

- A. Install base flashing over can't strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:
 - 1. Prime substrates with asphalt primer if required by roofing system manufacturer.
 - 2. Backer Sheet Application: Install backer sheet and heat weld to substrate as required by roofing system manufacturer.
 - 3. Flashing Sheet Application: Heat weld flashing sheet to substrate as required by roofing system manufacturer.
- B. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
- C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
 - 1. Seal top termination of base flashing with a strip of glass-fiber fabric set in MBR Flashing cement.
- D. Roof Drains: Flash drain using liquid applied flashing (PermaFlash) system. Clamp roofing membrane, flashing, and stripping into roof-drain clamping ring.
 - 1. Install stripping according to roofing system manufacturer's written instructions.
- E. Flash all penetrations using liquid applied flashing (PermaFlash) system.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.9 WALKWAY INSTALLATION

- A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
 - 1. Sweep away loose aggregate surfacing and set walkway pads in additional cold applied adhesive.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's Registered Roof Observer (RRO) to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTION AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 61 03

MANUFACTURED SHEET METAL ROOFING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Architectural standing seam metal roofing.
- B. Related Sections:
 - 1. Section 07 21 13 - Board Insulation: Rigid insulation under sheet metal roofing system.
 - 2. Section 07 62 00 - Sheet Metal Flashing and Trim.
 - 3. Section 07 90 00 - Joint Protection.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. American Architectural Manufacturers Association (AAMA)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. International Building Code (IBC)
 - 4. National Roofing Contractors Association (NRCA)
 - 5. Sheet Metal and Air Conditioning Contractors (SMACNA)
 - 6. Underwriters Laboratories Inc. (UL)
- B. References Standards:
 - 1. American Society of Testing and Materials (ASTM) A653/A653M, Standard Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-iron Alloy-coated (Galvannealed) by the Hot-dip Process.
 - 2. ASTM A755/A755M, Standard Specification for Steel Sheet, Metallic Coated by the Hot-dip Process and Prepainted by the Coil-coating Process for Exterior Exposed Building Products.
 - 3. ASTM A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-coated by the Hot-dip Process.
 - 4. ASTM B209, Standard Specification for Aluminum and Aluminum-alloy Sheet and Plate.
 - 5. National Roofing Contractors Association (NRCA), The NRCA Roofing and Waterproofing Manual.
 - 6. Sheet Metal and Air Conditioning Contractors (SMACNA), Architectural Sheet Metal Manual.
 - 7. Underwriters Laboratories Inc. (UL) 580, Tests for Uplift Resistance of Roof Assemblies.

1.3 DESIGN REQUIREMENTS

- A. Wind Loads: Design and size components to withstand positive and negative wind loads, including increased loads at building corners. See Drawing notes for specifications regarding wind loading requirements for this project.
- B. The roofing manufacturer shall design and furnish the roofing system that is custom engineered for this project and location in order to prevent uplift against the specified wind loading and shall submit documentation sealed by a professional engineer in the state of Texas that illustrates such conformance.
- C. Wind Uplift Resistance: UL 580; Class I-90.
- D. Seismic Loads: Design and size components to withstand seismic loads and sway displacement.
- E. Air Infiltration: Limit air leakage through roof assembly to 0.03 cam/square foot (0.0003 cubic meter/s/square meter) of wall area, measured at reference differential pressure across assembly of 6.24 psf (0.299 kPa) as measured in accordance with ASTM E283.
- F. Water Leakage: None, when measured in accordance with ASTM E331 with test pressure of 6.24 psf (0.299 kPa).
- G. Exterior Components: Accommodate the following without damage to system, components or deterioration of seals.
 - 1. Movement within system.
 - 2. Movement between system and perimeter framing components.
 - 3. Dynamic loading and release of loads.
 - 4. Deflection of structural support framing.
 - 5. Expansion and contraction from temperature range of 170 degrees F (95 degrees C) over 12-hour period.

1.4 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA Architectural Sheet Metal Manual and the NRCA Roofing and Waterproofing Manual.

1.6 QUALIFICATIONS

- A. Installer: Company specializing in manufacturing Products specified in this Section with minimum 3 years documented experience for the company and each installer who will be working on the project.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials causing discoloration or staining.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Coordinate with Work of Section 07 21 13 for insulation installed below roof assembly.

1.11 WARRANTY

- A. Furnish 20-year manufacturer warranty for sheet metal roofing against structural failure, corrosion, and water penetration.
- B. Furnish 20-year manufacturer warranty for metal finish against fading, chipping, chalking, and blistering.

PART 2 PRODUCTS

2.1 MANUFACTURED SHEET METAL ROOFING

- A. Manufacturers and Products:
 - 1. Centria Architectural Systems: Model SRS2.
 - 2. Ultra-Seam: US-200 Series.
- B. Architectural Standing Seam Metal Roofing: Factory formed metal roofing panel system with concealed fasteners.
 - 1. Panel Materials: Pre-finished Galvalume steel sheet.
 - 2. Panel Width: 12 inches.
 - 3. Panel Profile: ribbed.
 - 4. Seam Type: Sanding seam, mechanically seamed.
 - 5. Seam Height: 2".

2.2 SHEET METAL MATERIALS

- A. Pre-finished Galvalume Steel Sheet: ASTM A755/A755M coil coated.
 - 1. Base Metal: ASTM A792/A792M; with aluminum-zinc alloy coating.

2. Exposed Finish: Minimum three-coat fluoropolymer coating with minimum 70 percent polyvinylidene fluoride resin.
3. Unexposed Finish: Manufacturer's standard coating.

2.3 ACCESSORIES

- A. Fasteners: Type recommended by roofing manufacturer.
- B. Water Shield Membrane: ASTM D1970; self adhering polymer modified bituminous sheet material, slip-resistant surface, 40 mils (1.0 mm) thick, 36 inches (900 mm) wide, with strippable release paper to expose adhesive surface

2.4 FABRICATION

- A. Form sections shape as indicated on Drawings, accurate in size, square, and free from distortion or defects.
- B. Fabricate fascia, trim, flashing, and other metal components from same material as metal roof panels. Provide exposed metal surfaces with same finish as exposed face of metal roof panels.
- C. Fabricate cleats of same material as sheet, to interlock with sheet.
- D. Fabricate starter strips of same material as sheet, continuous, to interlock with sheet.
- E. Form pieces in longest possible lengths.
- F. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- G. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- H. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.

- 2.5 Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.
- C. Verify insulation is installed and ready for roof application.

3.2 INSTALLATION – WATER SHIELD MEMBRANE

- A. Install one 36-inch width of water shield membrane parallel with gutter along low side of roof edge, flush with face of eave edge flashing. Install per manufacturer's written directions.
- B. Extend water shield membrane minimum 4 feet up-slope up from gutter along low point of roof.

3.3 INSTALLATION – STANDING SEAM METAL ROOFING

- A. Conform to SMACNA and NRCA guidelines.
- B. Machine form standing seam between adjacent roofing panels. Hand form joints where machine forming is not possible.
- C. Terminate roofing panels with sheet metal trim and flashing for watertight installation. Close and conceal openings between roofing panels, panel seams, and roof substrate.
- D. Seal metal joints watertight.

3.4 INSTALLATION – FLASHING

- A. Secure flashings in place using concealed fasteners.
- B. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- C. Seal metal joints watertight.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not permit traffic over unprotected roof surface.

3.6 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
07 61 03-02	Qualifications: Submit a letter of certification as required by Paragraphs 1.6 A and B.	X	Per construction schedule
07 61 03-04	Shop Drawings: Indicate metal roofing panel profiles, jointing patterns, jointing details, fastening methods, flashings, terminations, and installation details.	X	Per construction schedule

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
07 61 03-05	Product Data: Submit data on metal types, finishes, and characteristics. Submit color charts for finish selection.	X	Per construction schedule
07 61 03-06	Samples: • Submit two samples of metal roofing, 18" long mounted on plywood backing illustrating typical seam, material, and finish.	X	Per construction schedule
07 61 03-07	Design Data: Submit structural design calculations for metal roofing signed and sealed by professional Engineer registered in the state of California.	X	Per construction schedule
07 61 03-08	Manufacturer's Installation Instructions: Submit instructions including special procedures for roofing penetrations, flashings, and perimeter conditions requiring special attention.	X	Per construction schedule

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal Wall Flashing and trim
- B. Gutters and downspouts
- C. Miscellaneous sheet metal work

1.2 PRODUCT DELIVERY AND STORAGE

- A. Delivery: Deliver all materials to the job site in original containers. Deliver to the various trades in sufficient quantities, and at appropriate phase of construction for installation of the products.
- B. Storage: Store materials off ground and under cover to protect from weather, damage and soiling.

1.3 SUBMITTALS

- A. Shop drawings and product data: Submit detailed shop drawings of metal flashing and sheet metal work, including gutters and downspouts, and installation details. Include manufacturers. Product data for material and manufactured items.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Stainless Steel flashing: Install stainless steel flashing with gauge as indicated on drawings, and meeting the requirements of ASTM A167, Type 304 or Type 316, with No. 4 finish. Where not indicated, install min. 26 gauge. Flashing shall be shop-formed prior to shipping where possible. All thru-wall flashing shall be shop-formed.
- B. Aluminum sheet metal: ASTM B209, 5005 or 3003-H-14 aluminum alloy as appropriate, clear anodized or epoxy coated. Where aluminum sheet thickness is not indicated, provide 0.0201-inch thickness.

- C. Fasteners and accessories: Furnish anchors and fasteners, washers, straps, and accessories required for a complete and finished installation. Fasteners and accessories shall conform with the following:
 - 1. Screws shall be standard stainless steel, brass, or bronze wood screws, as required. Sheet metal screws shall be self-drilling, self-tapping stainless steel or tempered non-corrosive steel of proper size and length.
 - 2. Screw heads shall be furnished with neoprene weatherhead washers.
 - 3. Straps and miscellaneous fastenings, where required, shall be stainless steel.
- D. Mastic: Asphalt mastic as recommended by flashing manufacturer.
- E. Isolating material: alkali-resistant bituminous paint or varnish.

PART 3 EXECUTION

3.1 PREPARATORY WORK

- A. Clean surfaces which are to receive wall flashings to insure that such surfaces are structurally sound and free from voids, cracks, sharp projections, dust, soil, grease, oil or excessive cement or mortar. Prior to installation, remove from surfaces projections which might puncture flashings. Fill voids in masonry with mortar.

3.2 INSTALLATION

- A. Install flashing and sheet metal work as indicated and in accordance with the approved shop drawings and SMACNA Architectural Sheet Metal Manual.
- B. Provide flashing, counterflashing, cap flashing, metal trim, and any other fabricated items and miscellaneous sheet metal work indicated to provide a complete and weathertight installation.
- C. Install gutters and downspouts where indicated on the drawings and in accordance with the approved shop drawings and relevant sections of the SMACNA Architectural Sheet Metal Manual.
- D. Install flashings in a manner to prevent moisture penetration through walls. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Extend thru-wall flashing beyond face of masonry and furnish a hemmed drip.
 - 1. Extend flashings beyond edge of lintels and sills at least 8" and turn up edge 2" on sides to form pan to direct moisture to exterior.
 - 2. Lap ends 3"; sides 6" and seal with mastic. Turn through-wall flashings up to 8" above lintels, beams, bond beams and counterflashings and out onto opposite wythe of masonry. Where back-up masonry does not occur above beams, turn flashing up to within 1/2" of finish floor slabs. Project flashing at openings a minimum of six inches beyond jambs and turn upside edges two inches. Provide weepholes spaced at minimum of 32" on center, or as otherwise indicated, in

head joints of first masonry course immediately above all flashings. Keep weepholes free of mortar, open for proper drainage.

- E. Sheet metal work shall be finished straight and true, with miters and joints accurately fitted. Exposed work shall be free of dents and other defects. Corners shall be reinforced and seams made waterproof. Edges of sheet metal shall be hemmed.
- F. Provide for expansion and contraction in sheet metal assemblies by means of expansion methods as presented in the SMACNA manual.
- G. Provide waterproof neoprene washer wherever fasteners penetrate sheet metal.

3.3 DISSIMILAR METALS

- A. Where sheet metal abuts or members into dissimilar materials, the juncture shall be executed in such a manner as to prevent electrolysis between the two materials. Protect metals by coatings recommended by the metal manufacturer or separated by building felt, neoprene, or mastic.

3.4 COMPLETED WORK

- A. Adjustment: Replace damaged flashing prior to covering and clean out any weepholes inadvertently closed or plugged.

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SECTION 07 71 23.13

MANUFACTURED DOWNSPOUT ADAPTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manufactured Downspout Adapters.

1.2 REFERENCES

- 1. Metal Fabrications as specified in Division – 5
- 2. Sheet Metal Flashing and Trim as specified in Division - 7

1.3 SUBMITTALS

- A. Product Data: Manufacturer's technical product data, installation instructions and general recommendations for each specified fabricated product.
- B. Shop Drawings: Show layouts, profiles, shapes, dimensions, and details for fastening, joining, supporting, and anchoring downspout adapters. Provide details at a scale of 3" equal to 1'-0".

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those described in this section and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Piedmont Downspout Adapters by Piedmont Pipe Construction, Inc.
(1.877.489.0911) 7907 Commerce Drive, Denver, North Carolina, 28037
www.piedmontpipe.com
 - 2. Approved substitute.

2.2 MATERIALS

- A. Downspout Adapter Body: Standard construction shall be 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304. Body size to be as indicated on the bid documents. Downspout bodies shall have the following finish:
 - 1. Powder Coat: 2-4 mil UV resistant polyurethane finish coating shall be electrostatic applied to the chemically prepared metal surfaces at a temperature not below 250 degrees. Color selected from manufactures standard pallet of colors by the Architect.
- B. Downspout Adapter Collar: Provide 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304, collar to accept the downspout shape and size as indicated in the drawings.
- C. Internal Sweep: Provide an electronically fused internal sweep elbow to ensure a smooth quiet transition of flow on all horizontal outlet boots. The internal sweep elbow shall be manufactured of 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304.
- D. Boot Discharge Outlets: Shall be ASTM A 240/A 240M, Type 304 stainless steel and shall be sized for connection to the roof drain leader piping.
- E. Self-Cleaning Debris Trap: All downspout boots shall be provided with a self-cleaning debris trap door. The self-evacuating debris trap door shall be 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304. The debris trap door shall be hinged and balanced to allow debris to be evacuated by the flow of water only. A removable stainless-steel debris screen, ASTM A 240/A 240M, Type 304 shall be installed to protect the roof drain leader piping from debris.

2.3 FABRICATION, GENERAL

- A. Metal Surfaces: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not user materials with exposed pitting, roller marks, or roughness.
- B. Conceal all anchoring fasteners, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Genera: Install downspout adapters according to manufacturer's written instructions. Anchor securely in place and capable of resisting forces specified. Install downspout adapters to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Seal anchor penetrations with elastomeric sealant as required by manufacturer of downspout adapters.

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SECTION 07 72 00

ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Roof hatches.
3. Pipe and duct supports.
4. Pipe portals.
5. Preformed flashing sleeves.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 055213 "Pipe and Tube Railings" for safety railing systems not attached to roof-hatch curbs.
3. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
4. Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units" for standard curbs specified with rooftop units.

1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.
- D. Delegated-Design Submittal: For roof curbs and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
 2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 1. Size and location of roof accessories specified in this Section.
 2. Method of attaching roof accessories to roof or building structure.
 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: As indicated on drawings.
- D. Material: Zinc-coated (galvanized) steel sheet, 0.064 inch (1.63 mm) thick.
 - 1. Finish: Mill phosphatized.
- E. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 3. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
 - 4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
 - 5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 6. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.

7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch (19-mm) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Security Grille: Provide where indicated.

2.3 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
- B. Type and Size: Single-leaf lid, 30 by 54 inches (750 by 1370 mm).
- C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.
- D. Hatch Material: Zinc-coated (galvanized) steel sheet.
 1. Thickness: Manufacturer's standard thickness for hatch size indicated.
 2. Finish: Baked enamel or powder coat.
 3. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
 1. Insulation: Polyisocyanurate board.
 - a. R-Value: 12.0 according to ASTM C 1363.
 2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 6. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
 7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.
- F. Hardware: Spring operators, hold-open arm, stainless-steel spring latch with turn handles, stainless-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

1. Provide two-point latch on lids larger than 84 inches (2130 mm).
 2. Provide remote-control operation.
- G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
1. Height: 42 inches (1060 mm) above finished roof deck.
 2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches (31 mm) in diameter or galvanized-steel tube, 1-5/8 inches (41 mm) in diameter.
 3. Flat Bar: Galvanized steel, 2 inches (50 mm) high by 3/8 inch (9 mm) thick.
 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 8. Fabricate joints exposed to weather to be watertight.
 9. Fasteners: Manufacturer's standard, finished to match railing system.
 10. Finish: Manufacturer's standard.
- a. Color: As selected by Architect from manufacturer's full range.
- H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
 2. Height: 42 inches (1060 mm) above finished roof deck.
 3. Material: Steel tube.
 4. Post: 1-5/8-inch- (41-mm-) diameter pipe.
 5. Finish: Manufacturer's standard baked enamel or powder coat.
- a. Color: As selected by Architect from manufacturer's full range.

2.4 PIPE AND DUCT SUPPORTS

- A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to 1-1/2-inch- (38-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with stainless-steel roller carrying assembly accommodating up to 7-inch- (178-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

2.5 PIPE PORTALS

- A. Curb-Mounted Pipe Portal: Insulated roof-curb units with welded or mechanically fastened and sealed corner joints, straight sides, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom; with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless-steel snaplock swivel clamps.
- B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless-steel snaplock swivel clamps.

2.6 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches (300 mm) high, with removable metal hood and slotted metal collar.
 - 1. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
 - 2. Diameter: As indicated on Drawings.
 - 3. Finish: Manufacturer's standard.
- B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
 - 1. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
 - 2. Height: 13 inches (330 mm).
 - 3. Diameter: As indicated on Drawings.
 - 4. Finish: Manufacturer's standard.

2.7 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation and mill phosphatized for field painting where indicated.
 - 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 - 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
 - 3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 - 4. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
 2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Mill Finish: As manufactured.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
 3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- D. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- F. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- G. Steel Tube: ASTM A 500/A 500M, round tube.
- H. Galvanized-Steel Tube: ASTM A 500/A 500M, round tube, hot-dip galvanized according to ASTM A 123/A 123M.

- I. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.8 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.
- C. Glass-Fiber Board Insulation: ASTM C 726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.
- D. Polyisocyanurate Board Insulation: ASTM C 1289, thickness and thermal resistivity as indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- F. Security Grilles: 3/4-inch (19-mm) diameter, ASTM A 1011/A 1011M steel bars spaced 6 inches (150 mm) o.c. in one direction and 12 inches (300 mm) o.c. in the other; factory finished as follows:
 - 1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
 - 3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.
- G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- H. Underlayment:
 - 1. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 - 2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
 - 3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
 - 4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 - 5. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

6. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
 7. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 8. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- I. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
 - J. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
 - K. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
 - L. Asphalt Roofing Cement: ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.9 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.

3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum or stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Attach ladder-assist post according to manufacturer's written instructions.
- F. Heat and Smoke Vent Installation:
1. Install heat and smoke vent so top perimeter surfaces are level.
 2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.
- G. Gravity Ventilator Installation: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.
- H. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- I. Preformed Flashing-Sleeve and Flashing Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

- J. Security Grilles: Weld bar intersections and, using tamper-resistant bolts, attach the ends of bars to structural frame or primary curb walls.
- K. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section "09 91 26 Painting Building".
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

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SECTION 07 84 00

FIRESTOPPING

PART 1 - GENERAL

1.1 APPLICABLE STANDARDS

- A. All materials shall be UL classified for firestopping materials.

1.2 SUBMITTALS

- A. Submit manufacturer's product data on firestopping materials.

1.3 DELIVERY AND STORAGE

- A. Delivery materials to project site in unbroken containers.
- B. Store materials in accordance with manufacturer's directions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Firestopping:
 - 1. Fire Barrier Caulk CP25N/S (No-Sag), 3M Products Division.
 - 2. Fire Barrier Caulk CP2S/L (Self-leveling), 3M Products Division.
 - 3. Fire-stopping products where listed in conjunction with the specific UL Design No. indicated on the Drawings, and as listed in the Underwriters Laboratories Inc. Fire-Resistance – Volume 1, latest addition
 - 4. Fire-stopping products as selected from the Underwriters Laboratories Inc. Fire-Resistance – Volume 1, latest addition, from the "Directory of Product Categories and Name of Companies, under "Wall Opening Protective Materials (CLIV) " to maintain the hourly ratings of fire resistive walls and partitions containing flush mounted devices such as outlet boxes, electrical cabinets and mechanical cabinets.
- B. Back-up Material: If required, type recommended by firestopping manufacturer

PART 3 – EXECUTION

- A. At the top and bottom of all fire-rated partitions as part of the applicable UL assembly.
- B. Around all penetrations through fire-rated partitions.

3.2 INSTALLATION

- A. Install all materials in accordance with manufacturer's instructions and as indicated on the Drawings.
- B. Thicknesses shall be as directed by the firestopping manufacturer.

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SECTION 07 90 00

JOINT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes joint sealants for the following applications:
 - 1. Exterior and interior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Joints between concrete blocks.
 - b. Joints between different materials.
 - c. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - d. Other areas where indicated on Drawings.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Pre-installation Conference: Conduct conference at Project Site.

1.5 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 PRODUCTS

- A. Elastomeric Sealants: Comply with ASTM C 920, Type S, Grade NS, Class 25, Use T (Traffic), NT (Non-traffic), M (Mortar), A (Aluminum), and O other substrates. Use the appropriate primer as directed by the manufacturer for the substrate to which the sealant is applied: Tremco – Vulkem 116.
- B. Elastomeric Sealants: Comply with ASTM C 920, Type S, Grade NS, Class 25, Use T (Traffic), NT (Non-traffic), M (Mortar), A (Aluminum), and O other substrates. Use the appropriate primer as directed by the manufacturer for the substrate to which the sealant is applied: Tremco – Dymetric 511.
- C. General Interior Sealant: Comply with ASTM C 920, Type S, Grade NS, Class 25, Use T (Traffic), NT (Non-traffic), M (Mortar), A (Aluminum), and O other substrates. Use the appropriate primer as directed by the manufacturer for the substrate to which the sealant is applied: Tremco – Tremflex 834.
- D. Self-Leveling Sealant: Comply with ASTM C 920, Type S, Grade NS, Class 25, Use T (Traffic), NT (Non-traffic), M (Mortar), A (Aluminum), and O other substrates. Use the appropriate primer as directed by the manufacturer for the substrate to which the sealant is applied: Tremco – THC-900 / THC-901.

- E. Sealant Color: Color shall be selected from manufacturers standard color selection that most closely matches the substrate color.
- F. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.4 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material), B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective

- coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Non-fire-rated hollow metal doors and frames for all exterior doors (except door 121).
 - 2. Fire-rated and non-fire-rated hollow metal doors for interior doors.
- B. Section Excludes:
 - 1. Acoustic Interior Doors and Frames (for doors 100C & 101A).

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.3 REFERENCED STANDARDS

- A. Industry standards governing this work of the latest issue at the date of this specification release, except as otherwise noted:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM A366 Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
 - c. ASTM A568 Steel, Carbon and High Strength Low Alloy, Hot Rolled Strip and Cold-Rolled Sheet.
 - 2. The National Association of Architectural Metal Manufacturers (NAAMM):
 - a. NAAMM CHM-1 Custom Hollow Metal Doors and Frames.
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 80 Fire Doors and Windows.
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. UL 10 Fire Test of Door Assemblies.
 - 5. American National Standards Institute (ANSI):
 - a. ANSI A115 (Series Standard Specification for Door and Frame Preparation for Hardware.
 - 6. Steel Door Institute "Recommended Specification: Standard Steel Doors and Frames" (S01-100) and as herein specified.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door design.

2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of moldings, removable stops, and glazing.
 9. Details of conduit and preparations for power, signal, and control systems.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to UBC Standard 7-4. Label each individual glazed lite.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Ceco Door Products; an Assa Abloy Group company.
 - 2. Curries Company; an Assa Abloy Group company.
 - 3. Steelcraft

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS AND FRAMES

- A. Interior Doors:
 - 1. Doors: 1-3/4 inches thick, full-flush type of sizes shown on Drawings. Grade II, heavy duty.
 - 2. Construct doors of two outer steel sheets laminated to a honeycomb core or welded to a grid of metal stiffeners.
 - 3. Steel Sheets: Not lighter than 18-gauge, prime quality, galvanized steel.
 - 4. Top and Bottom inverted closure Channels at all doors: Not less than 16-gauge galvanized steel, continuously welded to door face sheets.

5. Vertical Edge Channels: Not less than 12-gauge galvanized steel, full height of door, prepared for hinges and locks. Continuous weld face sheets to vertical channels. Lock edges of stiles beveled 1/8 inches in 2 inches.
 6. Finish edge joints of face sheets so that joint is smooth and invisible. Seal top and bottom edges against water penetration.
 7. Voids inside door shall be completely filled with material to prevent inside rusting and provide sound deadening.
 8. Size doors to provide clearances specified in Article 3.2 Paragraphs B and C.
 9. Pairs of doors with only one active leaf shall have an overlapping steel astragal fastened to inactive leaf with countersunk machine screws.
 10. Provide glazing per Section 08 80 00.
- B. Exterior Insulated Doors:
1. Provide door complying with all requirements of Interior Doors except as described below:
 2. At exterior locations and elsewhere as shown or scheduled, provide doors which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C236. Unless otherwise indicated, provide thermal-rated assemblies with U factor of 0.24 Btu/(hr•ft²•°F) or better.
- C. Exterior Door Frames:
1. Comply with SDI-100 of the types and styles indicated, for materials quality, metal gauges, and construction details.
 2. Provide hollow metal frames for doors, transom, sidelights, borrowed lights, and other openings as indicated, fabricated of minimum 14-gauge cold rolled furniture steel, with mitered and welded corners.
 3. Prepare frames to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.
 4. Provide 25-gauge steel plaster guards or mortar boxes, welded to frame, at back of hardware cutouts where installed in concrete, masonry or plaster openings.
 5. Protect inside faces of frames in plaster or masonry wall construction which are placed with anti-freeze additives using high-build fibered asphalt emulsion coating.
- D. Fire Doors:
1. Fire-rating Classification: As indicated on the drawings.
 2. Construction: rated doors and frames shall be constructed as above specified for hollow metal work, modified only to comply with design, materials, and construction as tested and approved by UL for ratings indicated.
 3. Labeling: doors shall bear UL Fire Door Label (listing mark) identifying rating as shown on schedule. Do not paint over UL Labels.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.5 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow metal doors: Fabricated from 16-gauge steel face sheets for exterior doors, and 18 gauge face sheets for interior doors.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
 - 5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
- E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8
 - 2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.
 - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 16 Sections.

2.6 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 2. Exterior doors and frames shall be galvanized and pretreated for finish painting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - b. Install frames with removable glazing stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - f. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - 4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
- D. Stops: Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

SECTION 08 11 14

KNOCK-DOWN STEEL DOOR FRAME

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Knock-down Fixed-Throat Steel Door Frames for all interior doors.

1.2 REFERENCES

- A. ANSI A 224.1 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- B. ANSI A 250.3 - Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
- C. ANSI/BHMA A 156.7 - Standard Template Hinge Dimensions.
- D. ASTM A 366/A 366M - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.
- E. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM B 117 - Practice for Operation of Salt Spray (Fog) Testing Apparatus.
- G. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
- H. ASTM D 1735 - Standard Practice for Testing Water Resistance of Coating Using Water Fog Apparatus.
- I. NFPA 80 - Standard for Fire Doors and Windows.
- J. Certification Listings; Warnock Hersey International Inc.

1.3 SYSTEM DESCRIPTION

- A. Performance Requirements: Frames for indicated fire-rated openings type-tested and approved by WHI testing agency.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature demonstrating compliance with referenced standards.
- B. Certificates: Manufacturer's certification that products comply with referenced standards.

- C. Shop Drawings: Indicate the following:
 - 1. Frame schedule.
 - 2. Frame sizes, profiles, and throat depths.
 - 3. Hardware preparation.
- D. Selection Samples: Submit two sets of color chips representing manufacturer's full range of available factory finishes.
- E. Verification Samples: Submit two samples, minimum 6 inches square, of each color of factory finish specified.
- F. Quality Control Submittals: Manufacturer's printed installation instructions for each specified product.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect products from moisture, construction traffic, and damage, store under cover.
- B. Place units on 4-inch (101 mm) high wood sills to prevent rust or damage.
- C. Do not use non-vented plastic or canvas shelters; should wrappers become wet, remove immediately.

1.6 SEQUENCING

- A. Furnish templates and printed instructions of manufacturers of door hardware specified in Section 08710 to manufacturer of products of this section in time for fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: REDIFRAME Products Division, Dunbarton Corporation, Inc.; 868 Murray Road, PO Box 6416, Dothan, AL 36302. ASD. Tel. (800) 633-7553. Fax. (334) 793-7022. Email: rediframe@dunbarton.com. www.dunbarton.com.

2.2 MATERIALS

- A. Galvanized Steel Sheet: 16 gauge, hot-dipped zinc coated steel conforming to ASTM A 653, Class A40 coating.
- B. Weatherstrip:
 - 1. Manufacturer's standard fire-rated weatherstrip material for fire-rated frames.
 - 2. Color: As selected by Owner.
- C. Fasteners: Types and sizes specified in manufacturer's installation instructions for project conditions.

2.3 MANUFACTURED UNITS

- A. Slip-on Fixed-Throat Steel Door Frames: Three-piece knock-down frames.
 - 1. Acceptable Product: REDIFRAME.
 - 2. Profile: Double-rabbeted for indicated door thicknesses, with 5/8-inch-high stop; throat dimension maximum 1/16 inch greater than indicated nominal thickness of partition to receive frame.
 - 3. 2-inch face and 1/2-inch returns.
 - 4. Material texture: Standard smooth.
 - 5. Finish: Factory primer finish, grey color.
- B. Silencers: Manufacturer's standard surface-mounted adhesive-applied silencer pads.

2.4 FABRICATION

- A. Steel Door Frames:
 - 1. Hinge Preparation:
 - a. Mortise frames for indicated size, type, and weight hinges; provide concealed reinforcement of same material as frame, minimum 14 gage material thickness.
 - b. Drill and tap holes for template hinges in accordance with ANSI/BHMA A156.7 template.
 - 2. Strike Preparation: Prepare single-door frames for indicated strikes in accordance with lockset manufacturers' templates and instructions.
 - 3. Closer Preparation: Provide reinforcement for frames indicated to receive closer hardware as follows:
 - a. Standard-arm mounting: Manufacturer's standard aluminum extrusion, alloy 6063-T5.
 - b. Parallel arm mounting: Same material as frame, minimum 16 gage material thickness.
 - 4. Emboss certifying agency's fire-resistance rating labels on frames for fire-rated openings.
 - 5. Silencers:
 - a. Single interior door frames: Mount 2 silencers on strike side, spaced 6 inches from top and bottom of door opening; mount one silencer at door head, at center of door opening.
 - b. Double interior door frames: Mount 2 silencers at door head, spaced 6 inches each way from meeting point of door swings.

2.5 FINISHES

- A. Chemical Treatment: Treat steel surfaces to promote paint adhesion.
- B. Factory Primer Finish: Meet requirements of ANSI A224.1
- C. Factory Baked Enamel Finish: Meet requirements of ANSI A250.3, and the following:
 - 1. 200-hour salt spray test in accordance with ASTM B 117.
 - 2. 700-hour humidity test in accordance with ASTM D 1735, with less than 5 percent No. 8 Blisters.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Non-Labeled Door Frames: Locate wall anchors near top and bottom of each frame and at intermediate points not over 24 inches apart. Erect frames plumb and brace securely until permanent anchors are set. Where floor fills occur, terminate bottom of frames at finish floor level and support frames with adjustable extension clip angles anchored to structural slab. Anchor bottom of frames to floors with power fasteners and build in wall anchors. Where frames require overhead struts, securely anchor to structural framing.
- B. Labeled Fire Door Frames: Install frames in accordance with UL requirements for labeled fire doors.

3.2 COMPLETED WORK

- A. Cleaning: Clean surfaces of grease, oil, dirt and other impurities. Touch-up scratched surfaces with primer of same generic type as that used for shop coat.
- B. Protection: Protect frames from damage during construction operations.

END OF SECTION

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pre-fit, pre-machined and pre-finished non-rated and fire-rated flush wood doors and related accessories.

1.2 REFERENCES

- A. AWI - Architectural Woodwork Institute, 8th Edition.
- B. WDMA – Window and Door Manufacturers Association: I.S. 1A-04 Industry Standard for Architectural Wood Flush Doors.
- C. NFPA-80 Standards for Fire Doors.
- D. Uniform Building Code: IBC 2003, Fire Test of Door Assemblies.
- E. Hardwood Plywood & Veneer Association.
- F. Steel Door Institute.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data:
 - 1. Submit in accordance with General Conditions.
 - 2. Indicate general construction, jointing methods, hardware, light and louver profiles, and locations of cutouts for glass and louvers.
- B. Samples:
 - 1. Submit samples of wood veneer and factory finishing in accordance with WDMA Industry Standard, Section F-4.
- C. Certification: Submit certification that doors and frames comply with IBC 2003.
- D. Guarantee: Submit copy of manufacturer's standard guarantee with submittal documentation.

1.4 QUALITY ASSURANCE

- A. Fire-Rated Wood Doors: Provide wood doors which are identical in materials and construction to units tested in door and frame assemblies in accordance NFPA 252 and which are labeled and listed for ratings indicated by ITS – Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.

- B. WDMA I.S. 1A-04 Industry Standard utilized for determination of performance duty levels for door, core, construction, finish, and other requirements.
- C. Temperature Rise Rating: At stairwell enclosures, provide doors which have Temperature Rise Rating of 250 degrees F maximum in 30 minutes of fire exposure

1.5 GUARANTY/WARRANTY

- A. Guarantee: Provide manufacturer's guarantee for all wood doors. Doors exhibiting defects in materials or workmanship including warp and delamination within guarantee period shall be replaced (including hanging and finishing) with new doors. These terms shall be part of the manufacturer's standard warranty.
- B. Guarantee period: Lifetime of original installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Eggers Industries.
- B. Algoma Hardwoods.

2.2 MATERIALS

- A. Door Performance Duty Level: WDMA I.S. 1A-04, Section P-1, Extra Heavy Duty. Door Aesthetic Grade: Premium.
- B. Door Construction:
 - 1. Non-Fire Rated Doors: Thickness: 1-3/4 inches, interior flush wood, bonded, solid core conforming to WDMA I.S. 1A-04, Section C-1 thru C-14 and the following;
 - a. Core: bonded particle core (PC) conforming to WDMA I.S. 1A-04.
 - b. Door construction shall conform to WDMA I.S. 1A-04 requirements.
 - c. Stiles: Hardwood to match face veneer over structural composite lumber (SCL), glued to core, 1-3/8" minimum after pre-fit.
 - d. Rails: Mill option hardwood or SCL, glued to core, 1-3/8" after pre-fit.
 - e. Facing: Wood veneer as specified.
 - 2. Fire Rated Doors: Thickness: 1-3/4 inches, interior flush wood, bonded, solid core conforming to WDMA I.S. 1A-04, Section C-1 thru C-14 and the following;
 - a. Core: bonded mineral core (FD) conforming to WDMA I.S. 1A-04.
 - b. Door construction shall conform to WDMA I.S. 1A-04 requirements.
 - c. Stiles: Hardwood to match face veneer over mineral composite, glued to core.
 - d. Top & bottom rails: Mineral composite as required by manufacturer's fire door authorities.
 - e. Facing: Wood veneer as specified.
 - f. Fire-Rated Wood Doors: Where fire-resistance classifications are shown or scheduled for wood door assemblies, provide doors which comply

with requirements of NFPA No. 80 and which have been tested and rated with single point hardware by UL. Provide UL Label on each door and panel.

- C. Wood Veneer:
 - 1. Door face veneers shall meet HPVA “A” grade quality standards conforming to WDMA I.S. 1A-04 for transparent or semi-transparent finish. Minimum face veneer thickness shall be 1/50” at 12% moisture content after finish sanding.
 - 2. Species: Select Birch.
 - 3. Face Cut: Rotary Flat Cut.
 - 4. Face Assembly: Book Match.
 - 5. Face Symmetry: Center Balanced Match.
- D. Adhesives:
 - 1. Adhesives: Face to core adhesives shall be Type I as classified by WDMA TM-6 “Adhesive Bond Test Method.”
- E. Core:
 - 1. Non-rated and 20-minute doors: ANSI C208.1-99 LD-2 Solid particleboard.
 - 2. Fire-rated 90-minute doors: Non-combustible mineral core.

2.3 FACTORY FINISHING

- A. Comply with referenced WDMA Section G-15, “Factory Finishing.”
- B. Pre-finish wood doors at manufacturer’s factory.
- C. Finish System: Match finish indicated in WDMA Section F-3, WDMA System #6.
- D. Finish to match Architect’s sample for color and sheen, or as specified by Owner.

2.4 ACCESSORIES

- A. Vision Frames:
 - 1. Non-rated Doors: Wood frames, lip-mold style, hardwood to match facing, pre-finished to match door.
 - 2. 20-minute Fire Rated Doors: Manufacturer’s tested metal clip with wood stops, lip-mold style, hardwood to match facing, pre-finished to match door.
 - 3. 90-minute Fire-rated Doors: ITS – Warnock Hersey or UL approved glazing system, primed for finish paint.
- B. Louver Assemblies:
 - 1. Non-rated Doors: Flush wood frames, inverted chevron, hardwood to match facing, pre-finished to match color.
 - 2. Fire-rated Doors: Louvers are not allowed in fire-rated doors.
- C. Astragals:
 - 1. Non-rated Doors: Surface wood, hardwood to match facing, pre-finished to match door.
 - 2. Fire-Rated Doors: Manufacturer’s listed pre-machined formed edge and astragal system, primed for finish paint.

2.5 FABRICATION

- A. Fabricate wood doors in accordance with requirements of WDMA I.S. 1A-04 Industry Standard.
- B. Fabricate fire rated doors in accordance with requirements of ITS - Underwriters' Laboratories, with metal label on each door including UL-10C.
- C. Fabricate mineral core doors with WDMA Industry Standards minimum hardware blocking options as follows:
 - 1. Provide HB-1 (head rail) and HB-4 (lock block) on all doors.
 - 2. Substitute HB-6 (mid rail) when exit devices are specified for door.
 - 3. Substitute HB-5 (stile) for pivots or when flush bolts are specified for door.
- D. Provide doors with minimum ¼ inch thick edge strips, of wood species to match face veneers except as required for fire rating.
- E. Make cutouts and provide stops for glass and louvers. Install wood door louvers. Seal cut-outs prior to installation of moldings.
 - 1. For full light doors: Provide cutout from flush wood door, with vertical grain direction.
- F. Bevel lock and hinge edges of single acting doors 3 degrees or 1/8 inch in 2 inches. Radius strike edge of double acting swing doors as required by pivot hinge manufacturer.
- G. Prepare doors to receive hardware. Refer to Section 08 71 00 - Hardware and NFPA 80 for hardware requirements including UL-10C.
 - 1. Prefit and bevel to net opening size less approximately 1/4 inch in width on single swing doors 3/16 inch in width for paired doors. Provide 5/8-inch clearance above bottom of frame, unless otherwise indicated by sill condition drawings. Provide 1/8-inch clearance at top of door.
 - 2. Slightly ease vertical edges.
- H. Fire Rated Pair of Doors; greater than 20-minutes: Supply overlapping astragals, metal edge sets or concealed intumescent material as required by NFPA 80 or by door manufacturer's fire door authorities. If an astragal is required, to comply with fire rated labeling requirements for pairs of fire rated doors, provide door manufacturer's standard tested astragal assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installed door frames before hanging doors.
- B. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed in accordance with SDI-105 and SDI-122.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

- D. Installation of improper product constitutes full acceptance and responsibility for material and conditions.

3.2 INSTALLATION

- A. Handle and store doors in accordance with recommendations of WDMA I.S. 1A-04, Section J-1.
- B. Condition doors to average temperature and humidity in area of installation for not less than 48 hours prior to installation.
- C. Install in neat and workmanlike manner, free from hammer or tool marks, open joints or slivers, set plumb, level, square and true.
- D. Retain manufacturer's packaging to place over installed doors after final cleaning.
- E. Adjust pre-finished doors and hardware and other moving or operating parts to function smoothly and correctly in accordance with SDI-122.
- F. Ensure that smoke gaskets are in place before pre-finished door installation.
- G. Remove and replace all doors found to be warped, twisted, bowed, or otherwise damaged beyond manufacturer's specified allowances and tolerances. Do not install doors which cannot be properly fitted to frames.

3.3 CLEANING AND PROTECTION

- A. Clean prefinished doors in accordance with AWI, Appendix, page A-637.
- B. Place manufacturer's packaging over installed doors after final cleaning; remove after Architect's instructions.
- C. At clear finished doors, do not partially cover door surfaces with paper, cardboard, or any other opaque covering that will create uneven aging of wood veneer.
- D. Refinish or replace finished doors damaged during installation.

END OF SECTION

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SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
 - 1. Section 07 72 00 "Roof Accessories" for roof hatches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.
- C. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Maxam Metal Products Limited.
 - c. MIFAB, Inc.
 - d. Nystrom, Inc.
2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As required to suit application.
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
6. Latch and Lock: Cam latch, screwdriver operated.

B. Exterior Flush Access Doors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Maxam Metal Products Limited.
 - c. MIFAB, Inc.
 - d. Nystrom, Inc.
2. Description: Weatherproof assembly, with face of door fit flush with frame and with exposed frame. Include extruded door gaskets and minimum 2-inch-thick (50-mm-thick) fiberglass insulation.
3. Locations: Wall.
4. Door Size: As required to suit application.
5. Stainless-Steel Sheet for Door: Nominal 0.062 inch (1.59 mm), 16 gage, No. 4 finish.
6. Frame Material: Same material, thickness, and finish as door.
7. Latch and Lock: Cam latch operated by handle, without lock.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Maxam Metal Products Limited.
 - c. MIFAB, Inc.
 - d. Nystrom, Inc.
2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with exposed flange, self-closing door, and concealed hinge.
3. Locations: Wall.
4. Door Size: .
5. Fire-Resistance Rating: Not less than that of adjacent construction.

6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
7. Latch and Lock: Self-latching door hardware, operated by knurled-knob.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

E. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

SECTION 08 33 10
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies overhead coiling metal doors and operators.
 - 1. Type: Insulated overhead coiling doors.
 - 2. Operation: Electric motor operation.
 - 3. Mounting Configuration: Face of wall mounting.

1.2 REFERENCES

- A. ASTM A653/A653M
- B. ASTM A36
- C. NEMA Design B

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Size, location, configuration, and construction.
 - 2. Details at adjoining building construction, including built-in and embedded items.
 - 3. Summary of forces and loads on walls and jambs.
 - 4. Wiring diagrams for power, signal, and control systems.
- B. Product Data:
 - 1. Installation instructions.
 - 2. Information describing fire-release system, including electrical rough-in instructions.
- C. Operating and Maintenance Manual: Parts lists, wiring diagrams, scheduled maintenance, and other relevant data.

1.4 QUALITY ASSURANCE

- A. Door Assemblies: Provide operating overhead coiling doors with operator, and controls as a complete unit produced by one manufacturer for entire Project.
- B. Operation Cycle Requirements: Not less than 100,000 cycles.
- C. R-Value: R-7.7 min.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

2.2 MANUFACTURER

Overhead Door Corp. (ref. Manuf.)

INSULATED ROLL- UP DOOR

Stormtite 625 series insulated, face of wall mounted

- A. The Cookson Co.
- B. Cornell Iron Works Inc.
- C. McKeon/J. G. Wilson Corp.
- D. Atlas Roll-Lite Overhead Doors.
- E. Wayne Dalton Corp.

2.3 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtain: Curtain slats at non fire rated doors will be interlocking, roll – formed, fully foamed in place, insulated, flat profile.
 - 1. Slats: The interior and exterior slats to be fabricated from minimum 20-gauge galvanized steel, per ASTM A 653/A 653M.
 - 2. Configuration: Flat-profile slats type F-265 I for non-fire rated doors as manufactured by Overhead Door Corp.
 - 3. Insulation: R-Value - 7.7, encased within metal slat, flame spread 75 or less, smoke developed 450 or less.
- B. Endlocks: Malleable iron castings galvanized after fabrication, secured to alternate curtain slats with galvanized rivets.
- C. Windlocks: Malleable iron castings secured to curtain slats with galvanized rivets; provide on doors exceeding 16 feet wide. Space 24 inches o.c. on both edges of curtain. Provide continuous bar for holding windlocks in jamb guides.
- D. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8-inch-thick, galvanized steel.
- E. Sill Gasket: Replaceable, flexible vinyl or neoprene fastened between bottom bar angles.
- F. Curtain Jamb Guides: Steel angles or channels built from minimum 3/16-inch steel sections, complying with ASTM A 36, galvanized after fabrication. Slot bolt holes for track adjustment. Provide continuous integral wear strips and removable stops to prevent over-travel.
- G. Continuous Wall Angle: Secure to wall framing with minimum 3/8-inch bolts 30 inches o.c. maximum. Extend above door opening to support coil brackets. Place anchor bolts on exterior wall guides so they are concealed when door is closed.

- H. Brackets: hot rolled galvanized steel to support counterbalance curtain and hood.
- I. Weather Seals: 1/8-inch-thick continuous vinyl or neoprene.
 - 1. Heads: Secure sheet to inside of curtain coil hood.
 - 2. Jambs: Secure strip to exterior side of jamb guides.

2.4 COUNTERBALANCING MECHANISM

- A. General: Adjustable steel helical torsion spring designed for 100,000 cycle life design, mounted around steel shaft and in steel tube or pipe barrel; connect to curtain with barrel rings. Bearings for rotating members: grease-sealed or self-lubricating graphite.
- B. Spring Barrel: Hot-formed structural-quality carbon steel, welded or seamless pipe; limit deflection to 0.03 inch per foot under full load.
- C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs sized to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast steel barrel plugs.
- D. Counterbalance Torsion Rod Shaft: Cold-rolled steel sized to hold fixed spring ends and carry torsion load.
- E. Mounting Brackets: Manufacturer's standard design, cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.
- F. Hood: Form to entirely enclose coiled curtain and operating mechanism, attach to end brackets, provide with internal baffle weatherseal. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for hoods. Provide intermediate support brackets to prevent sag.
 - 1. Hoods: Steel hoods with minimum 0.0276-inch-thick (24-gage) hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

2.5 FINISH

- A. Slats and hood shall be galvanized steel in accordance with ASTM A 653/ A653M and receive rust inhibitive, roll coating process, including bonderizing, 0.2 mills thick baked on prime paint, and 0.6 mills thick baked – on polyester topcoat. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except tightly joined and lubricated surfaces, with door manufacturer's standard rust- inhibitive primer. Use primer that is compatible with finish painting.
- B. Color: Polyester topcoat – color as selected by Owner.

2.6 ELECTRIC DOOR OPERATORS -OVERHEAD COILING DOORS

- A. General: Furnish U.L. listed electric motor and factory prewired motor control panel with disconnect over-load protection, starter and terminal board strip to interface with control station and devices, gear reduction unit, drive from reduction box to gear wheel mounted on counterbalance shaft, disconnect release for manual operation, solenoid operated brake, remote control stations, control devices, conduit and wiring from controls

to motor and control stations, and complete accessories for proper operation and maintenance. Hand-operated Disconnect: Automatically engages sprocket and chain operator and releases brake for manual operation, with interlock device to prevent motor from operating when manual operator is engaged; accessible from floor level.

- B. Operator: Bracket mounted type with motor that may be removed without disturbing limit switch adjustment or affecting manual operator, with chain and sprocket secondary drive. Provide motor and drive assembly of horsepower and design as determined by door manufacturer for size of unit required.
- C. Electric Motors: Provide high starting torque, reversible, 460V, three phase, NEMA Design B, Class F insulated, with overload protection. Provide starters for each motor. Coordinate wiring requirements and current characteristics of motors with building electrical system.
 - 1. Travel Speed: Between 8 inches and 12 inches per second.
 - 2. Type: Manufacturer's standard.
 - 3. Location: Manufacturer's standard.
 - 4. Install Commercial Operator Model RHX, 1/2 horsepower, as manufactured by Overhead Door, with auxiliary Input/Output module – part no. OPABIOX
- D. Control Station:
 - 1. Operation: Pull cord that operates with one pull for Open, Close, and Stop.
 - 2. Enclosure: Interior units (at all doors), full-guarded, surface-mounted, heavy-duty, with general-purpose NEMA Type 1 enclosure. Exterior units (at all doors), full-guarded, standard-duty, surface-mounted, weatherproof, NEMA Type 4 enclosure.
 - 3. Quantity and Location: On both sides of door. Locate on left side when facing door.
 - 4. Mounting Height: Bottom of pull cord at 4'-6" A.F.F.
- E. Automatic Reversing Control:
 - 1. Photoelectric sensors that produce a non- visible beam across the bottom of the door opening.
 - 2. Electric sensing edge – extend full width of door bottom; locate within neoprene or rubber astragal mounted to bottom door rail. Contact with switch while closing will immediately reverse travel direction to fully opened position.
 - 3. Connect to control circuit through retracting safety cord and reel, or self-coiling cable.
 - 4. Provide electrically actuated automatic bottom bar.
- F. Limit Switches: Adjustable, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install door and operating equipment according to approved Shop Drawings, manufacturer's instructions, and as specified. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.
- B. Testing: After installation, lubricate, test, and adjust doors to operate easily, free from warp, twist, or distortion.
 - 1. Training: Train Owner's maintenance personnel on door operation, testing, servicing, preventive maintenance, and procedures for resetting closing devices after activation.
 - 2. Schedule training with Owner with 7 days advance notice.

END OF SECTION

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SECTION 08 41 13

ALUMINUM FRAMED ENTRANCES AND STOREFRONTS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes: Kawneer Aluminum Entrance, entrance framing, glass and glazing, and door hardware and components.
 - 1. Kawneer Aluminum Entrance and Entrance Framing:
 - a. Exterior Doors: Insulclad 560 thermal entrance door system – designed for thermal efficiency and heavy traffic conditions.
 - b. Exterior Entrance Framing: TriFab 451 Framing system.

1.2 SYSTEM DESCRIPTION

- A. Entrance Performance Requirements:
 - 1. Air Infiltration: For single acting offset pivot or butt hung entrances in the closed and locked position, the test specimen shall be tested in accordance with ASTM E 283 at a pressure differential of 6.24 psf. A single 3'0" x 7'0" entrance door and frame shall not exceed 0.50 cfm per linear foot of perimeter crack.
 - 2. Structural: Corner strength shall be tested per Kawneer's dual moment load test procedure and certified by an independent testing laboratory to ensure weld compliance and corner integrity.

1.3 SUBMITTALS

- A. General: Prepare, review, approve, and submit specified submittals in accordance with "Conditions of the Contract" and Division 1 Submittals Sections. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract."
- B. Quality Assurance/Control Submittals:
 - 1. Test Reports: Submit certified test reports showing compliance with specified performance characteristics.

1.4 WARRANTY

- A. Project Warranty: Refer to "Conditions of the Contract" for project warranty provisions.
- B. Manufacturer's Product Warranty: Submit, for Owner's acceptance, manufacturer's warranty for entrance system as follows:
 - 1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by Kawneer. In addition, welded door corner construction shall be supported with a limited lifetime warranty for the life of the door under normal use.

1.5 QUALITY ASSURANCE

- A. Qualifications:

1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.
 2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction, approving acceptable installer and approving application method.
- B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- B. Packing, Shipping, Handling, and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle entrance doors and components to avoid damage. Protect entrance doors against damage from elements, construction activities, and other hazards before, during and after entrance installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS (ACCEPTABLE MANUFACTURERS/PRODUCTS)

- A. Acceptable Manufacturers:
1. Kawneer Company, Inc.
555 Guthridge Court
Technology Park/Atlanta
Norcross, GA 30092
Tel: 770-449-5555
Fax: 770-734-1560
 2. Proprietary Product(s)/System(s): Kawneer Aluminum Entrance.
 - a. Insulclad 560 thermal entrance door system
 - b. Finish/Color: (See 2.6 FINISHES)

2.2 MATERIALS

- A. Aluminum (Entrances and Components):
1. Material Standard: ASTM B 221; 6063-T5 alloy and temper
 2. The door shall be 2 1/4" thick, with stile and rail face dimensions of:

<u>Door</u>	<u>Vertical Stile</u>	<u>Top Rail</u>	<u>Bottom Rail</u>
Insulclad 560®	5"	5"	10"
 3. Glass stops shall be square.

4. All walls of the door members shall be a minimum 0.188" nominal in thickness with 0.050" thick glass stops.
 5. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of entrance members are nominal and in compliance with Aluminum Standards and Data, published by The Aluminum Association.
- B. Glazing gaskets shall be either EPDM elastomeric extrusions or a thermoplastic elastomer.
 - C. Provide adjustable glass jacks to help center the glass in the door opening.
 - D. TriFab 451 Center Glazed system, with 4-1/2" deep x 2" sightline.
 - E. Doors: All exterior doors, windows, and sidelites shall accept double-glazed, insulated glass.

2.3 ACCESSORIES

- A. Fasteners: Where exposed, shall be aluminum, stainless steel or plated steel.
- B. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

C. Entrance Door Hardware

Note: Final hardware selection is as follows, with changes pending consideration given to Owner's plant-wide standards as applicable. Doors with Magnalocks shall have card reader both sides and associated electrical wiring shall be by others. When exit devices are dogged using the electric dogging, the card reader shall release the mag lock for authorized ingress and egress. See ingress and egress notes following the Hardware Set. Mag locks shall be tied into the building fire alarm system. **HARDWARE VENDOR SHALL CONSULT WITH CHEVRON PHILLIPS FACILITIES MANAGER PRIOR TO FINAL HARDWARE APPROVAL, AND PRIOR TO SUBMITTING SHOP DRAWINGS.**

D. Door Hardware & Accessories

1. Kawneer Weatherstripping:
 - a. Meeting stiles on pairs of doors shall be double weathered with one consisting of an adjustable astragal.
 - b. The door weathering on a single acting door and frame (single or pairs) shall be Kawneer Sealair® weathering. This is comprised of a thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing.

E. HARDWARE SET #01

Door: 121

2	Continuous Hinge	CFMSLFHD x LAR	628	PE
2	Mag Lock	M62	US32D	SE
1	Power Supply	BPS-24-1	USP	SE
2	CVR Exit Device	7120 PB626F	US26D	YA
2	IC Cylinder	As Required	26D	YA
2	Closer	7500	689	NO
2	Sidewalk Stop	481	26D	RO

1	Rain Drip Cap	346C x FW	628	PE
2	Door Bottom	315CN	628	PE
1	Threshold	2005AV	719	PE
1	Perimeter Gaskets	By Frame & Door Manufacturer		
2	Card Reader	Related Section – Electronic Safety and Security		
1	Emergency Glass Break Door Release System	Related Section – Electronic Safety and Security		

Notes

Ingress: Key locks or unlocks lever (non-energized mag lock); energized mag lock, ingress by card reader (mag lock, fail safe).

Egress: Exit device (non-energized mag lock); energized mag lock, egress by card reader (mag lock, fail safe); emergency glass break door release system.

2.4 RELATED MATERIALS

A. Sealants: Refer to Joint Treatment (Joint Protection) Section.

B. Glass: Refer to Glass and Glazing Section.

2.5 FABRICATION

A. Entrance System Fabrication:

1. Door corner construction shall consist of mechanical clip fastening, SIGMA deep penetration plug welds and 1-1/8" long fillet welds inside and outside of all four corners. Glazing stops shall be hook-in type with EPDM glazing gaskets reinforced with non-stretchable cord.
2. Accurately fit and secure joints and corners. Make joints hairline in appearance.
3. Prepare components with internal reinforcement for door hardware.
4. Arrange fasteners and attachments to conceal from view.
5. Door frame moldings 4-1/2" in depth, which provide structural support for the door(s), shall be full tubular sections with minimum wall thicknesses – specify 1/8" at exposed faces and sides, 5/16" at recessed sidewalls receiving mortised or concealed hardware.

2.6 FINISHES

A. Factory Finishing:

1. Clear Mill anodized. All exterior and interior aluminum framing systems shall be anodized to match.

2.7 SOURCE QUALITY CONTROL

A. Source Quality: Provide aluminum entrances specified herein from a single source.

1. Building Enclosure System: When aluminum entrances are part of a building enclosure system, including storefront framing, windows, curtain wall system and related products, provide building enclosure system products from a single source manufacturer.

- B. Fabrication Tolerances: Fabricate aluminum entrances in accordance with entrance manufacturer's prescribed tolerances.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive storefront system and sill plate is level in accordance with manufacturer's acceptable tolerances.
 - 1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.2 INSTALLATION

- A. General: Install entrance system in accordance with manufacturer's instructions and AAMA storefront and entrance guide specifications manual.
 - 1. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 - 2. Provide alignment attachments and shims to permanently fasten system to building structure.
 - 3. Align assembly plumb and level, free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.
 - 4. Set thresholds in bed of mastic and secure.
 - 5. Adjusting: Adjust operating hardware for smooth operation.
- B. Related Products Installation Requirements:
 - 1. Sealants (Perimeter): Refer to Section 7 - Joint Protection (Sealants).
 - 2. Glass: Refer to Section 8 - Glazing.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

3.3 PROTECTION AND CLEANING

- A. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
- B. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum entrances from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants. Remove and replace damaged aluminum entrances at no extra cost.

END OF SECTION

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SECTION 08 44 14

GLAZED ALUMINUM WINDOWS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes: Kawneer Architectural Aluminum Windows, including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing window framing.
 - 1. Types of Kawneer windows include:
 - a. 8400TL Isolock with 4" deep frame.

1.2 SYSTEM DESCRIPTION

- A. Window Performance Requirements:
 - 1. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" :
 - a. Basic Wind Speed: 120 mph (3-Second Gust)
 - b. Importance Factor: 1.0
 - c. Exposure Category: C.
 - 2. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft² (0.3 l/s·m²) at a static air pressure differential of 6.24 psf (300 Pa).
 - 3. Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a static air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.
 - 4. Water Resistance, (dynamic): The test specimen shall be tested in accordance with AAMA 501.1. There shall be no leakage at an air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.
 - 5. Uniform Load: A static air design load of 40 psf (1915 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member at design load. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.
 - 6. Thermal Transmittance (U-factor): The thermal transmittance (U-factor) shall not be more than:
 - a. Captured - 0.65 (clear) when tested to AAMA 1503
 - b. SSG – 0.58 (clear) when tested to AAMA 1503.
 - 7. Condensation Resistance (CRF):
 - a. When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than:
 - 1) Captured - 68_{frame} and 60_{glass} (clear).
 - 2) SSG - 72_{frame} and 62_{glass} (clear).
 - b. When tested to CSA-A440-00, the Condensation Index shall not be less than:
 - 1) Captured - 61_{frame} and 51_{glass} (clear).
 - 2) SSG - 64_{frame} and 54_{glass} (clear).

8. Sound Transmission Loss: When tested to ASTM E90 and ASTM E1425, the Sound Transmission Class (STC) and Outdoor/Indoor Transmission Class (OITC) shall not be less than:
 - a. Captured - STC 31 or OITC 26 based upon 1" insulating glass (1/4", 1/2" AS, 1/4"),
 - b. SSG - STC 32 or OITC 26 based upon 1" insulating glass (1/4", 1/2" AS, 1/4").
9. Impact Resistance: In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E 1996 and ASTM E 1886 referenced herein as follows:
10. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the large missile test of ASTM E 1996.

1.3 SUBMITTALS

- A. General: manufacturer's product data, shop drawings, and samples.
- B. Quality Assurance/Control Submittals:
 1. Test Reports: Submit certified test reports showing compliance with specified performance characteristics.

1.4 WARRANTY

- A. Project Warranty: Refer to "Conditions of the Contract" for project warranty provisions.
- B. Manufacturer's Product Warranty: Submit, for Owner's acceptance, manufacturer's warranty for curtain wall system as follows:
 1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by Kawneer.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project and who is acceptable to product manufacturer.
 2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction, approving acceptable installer and approving application method.
- B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

- B. Packing, Shipping, Handling, and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle material and components to avoid damage. Protect window material against damage from elements, construction activities, and other hazards before, during and after window installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS (ACCEPTABLE MANUFACTURERS/PRODUCTS)

- A. Acceptable Manufacturers:
 - 1. Kawneer Company, Inc.
555 Guthridge Court,
Technology Park/Atlanta,
Norcross, GA 30092
Telephone: 770 449 5555
Fax: 770 734 1560
 - 2. Proprietary Product/System: Kawneer Window Assemblies
 - a. Series: 8400TL Isolock with PVC perimeter head, jamb, and sill receptors.
 - b. Finish/Color: (See 2.06 Finishes).
- B. Substitutions: None

2.2 MATERIALS

- A. Aluminum (Window Components):
 - 1. Material Standard: Extruded Aluminum, ASTM B 221, 6063-T6 alloy and temper.
 - 2. Member Wall Thickness: Each framing member shall have a wall thickness sufficient to meet the specified structural requirements.
 - 3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

2.3 ACCESSORIES

- A. Fasteners: Where exposed, shall be Stainless Steel.
- B. Gaskets: Glazing gaskets shall comply with ASTM C 864 and be extruded of a silicone compatible EPDM rubber that provides for silicone adhesion.
- C. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- D. Thermal Barrier: Thermal separator shall be extruded of a silicone compatible elastomer that provides for silicone adhesion.

2.4 RELATED MATERIALS

- A. Sealants: Refer to Joint Treatment (Sealants) Section.
- B. Glass: Refer to Glass and Glazing Section.

2.5 FABRICATION

- A. General:
 - 1. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly yet enabling installation and dynamic movement of perimeter seal.
 - 2. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof.
 - 3. Prepare components to receive anchor devices. Fabricate anchors.
 - 4. Arrange fasteners and attachments to conceal from view.
 - 5. Shop assemble frames to the greatest extent possible and shop seal all horizontal to vertical joints.

2.6 FINISHES

- A. Shop Finishing:
 - 1. Clear mill anodized – or as otherwise specified by Owner. All exterior and interior aluminum framing systems shall be anodized to match.

2.7 SOURCE QUALITY CONTROL

- A. Source Quality: Provide aluminum windows specified herein from a single source.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive windows and receptors in accordance with manufacturer's acceptable tolerances.
 - 1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.2 INSTALLATION

- A. General: Install windows plumb, level, and true to line, without warp or rack of frames with manufacturer's prescribed tolerances and installation instructions. Provide support and anchor in place.
 - 1. Dissimilar Materials: Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
 - 2. Glazing: Glass shall be outside glazed and held in place with extruded aluminum pressure plates anchored to the mullion using stainless steel fasteners spaced no greater than 9" on center.

- B. Related Products Installation Requirements:
 - 1. Sealants (Perimeter): Refer to Division 7 Joint Treatment (Sealants) Section.
 - 2. Glass: Refer to Division 8 Glass and Glazing Section.
 - a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

3.3 FIELD QUALITY CONTROL

- A. Field Tests: Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.
 - 1. Testing: Testing shall be performed per AAMA 503 by a qualified independent testing agency. Refer to Division 1 Testing Section for payment of testing and testing requirements.
 - a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.09 cfm/ft², whichever is greater.
 - b. Water Infiltration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 8 psf.
- B. Manufacturer's Field Services: Upon Owner's request, provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

3.4 PROTECTION AND CLEANING

- A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum windows from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
- B. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

END OF SECTION

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SECTION 08 71 00 - A

DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.

- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity.

Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.

3. Twenty five years for manual overhead door closer bodies.
4. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

- a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
- 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
- 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
- 5. Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
 - 1. Manufacturers:
 - a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 - 1. Manufacturers:
 - a. Hager Companies (HA) - ETW-QC (# wires) Option.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
 - c. Stanley Hardware (ST) - C Option.
- B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a removable service panel cutout accessible without de-mounting

door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

- a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) - SER-QC (# wires) Option.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

- 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
- 2. Furnish dust proof strikes for bottom bolts.
- 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
- 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

- a. Ives (IV).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- c. Trimco (TC).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

- 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
- 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
- 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
- 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

5. Manufacturers:

- a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- b. Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Match Facility Restricted Keyway.
- C. Interchangeable Cores: Provide small format interchangeable cores as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- E. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
 - 4. Permanent Control Keys (where required): Two (2).
- F. Construction Keying: Provide temporary keyed construction cores.
- G. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. dormakaba Best (BE) - 45H Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.9 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
 1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as

required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. dormakaba Precision (PR) - Apex 2000 Series.
 - d. Von Duprin (VD) - 35A/98 XP Series.

2.10 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. LCN Closers (LC) - 4040 Series.
 - c. Norton Door Controls (NO) - 7500 Series.

2.11 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

- a. Ives (IV).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- c. Trimco (TC).

- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

- a. Rixson Door Controls (RF).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- c. Sargent Manufacturing (SA).

2.12 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

- 1. National Guard Products (NG).
- 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

3. Reese Enterprises, Inc. (RE).
4. Zero (ZE).

2.13 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.14 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
 2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handling and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 - 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.
- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. RU - Corbin Russwin
5. AW - Arrow Lock
6. SA - SARGENT
7. OT - Other
8. RF - Rixson
9. NO - Norton

Hardware Sets

Set: 1.0

Doors: B107

1 Continuous Hinge	CFMXXSLF-HD1		PE
1 Continuous Hinge	CFMXXSLF-HD1 SER		PE
2 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
2 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Perimeter Gasketing	By Door and Frame Manufacturer		OT
2 Sweep	315CN TKSP		PE
2 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Notes: Coordinate hardware with Aluminum Door and Frame manufacturer. Provide special templates, brackets, spacers, drop plates and fasteners as required.

Door normally closed and locked.

Entry by valid credential or manual key override.

Always free egress.

Upon loss of power, door remains locked.

Set: 2.0

Doors: B111A, G101

1 Continuous Hinge	CFMXXSLF-HD1		PE
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
1 Door Pull	BF157 Mtg-Type 12XHD	US32D	RO
1 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Perimeter Gasketing	By Door and Frame Manufacturer		OT
1 Sweep	315CN TKSP		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Notes: Coordinate hardware with Aluminum Door and Frame manufacturer. Provide special templates, brackets, spacers, drop plates and fasteners as required.

Door normally closed and locked.

Entry by valid credential or manual key override.

Always free egress.

Upon loss of power, door remains locked.

Set: 3.0

Doors: A106A

1 Continuous Hinge	CFMXXSLF-HD1		PE
1 Rim Exit Device, Storeroom	70 8804	US32D	SA
1 Electric Strike	By Security Contractor		OT
1 Door Pull	BF157 Mtg-Type 12XHD	US32D	RO
1 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Perimeter Gasketing	By Door and Frame Manufacturer		OT
1 Sweep	315CN TKSP		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Notes: Coordinate hardware with Aluminum Door and Frame manufacturer. Provide special templates, brackets, spacers, drop plates and fasteners as required.

Door normally closed and locked.

Entry by valid credential or manual key override.

Always free egress.

Upon loss of power, door remains locked.

Set: 4.0

Doors: D105A

5 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Hinge, Full Mortise, Hvy Wt	T4A3386 QC 4-1/2" x 4-1/2"	US32D	MK
2 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
2 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Gasketing	2891AS TKSP		PE
1 Rain Guard	346C TKSP		PE
2 Sweep	315CN TKSP		PE
1 Split Astragal	303AS TKSP		PE
2 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Notes: Door normally closed and locked.

Entry by valid credential or manual key override.

Always free egress.

Upon loss of power, door remains locked.

Set: 5.0

Doors: H102A, H104A

6 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Exit Latch	ML2010 NSP M30	626	RU
2 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Gasketing	2891AS TKSP		PE
1 Rain Guard	346C TKSP		PE
2 Sweep	315CN TKSP		PE
1 Split Astragal	303AS TKSP		PE
2 Door Position Switch	By Security Contractor		OT

Set: 6.0

Doors: H103

6 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
2 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Gasketing	2891AS TKSP		PE
1 Rain Guard	346C TKSP		PE
2 Sweep	315CN TKSP		PE
1 Split Astragal	303AS TKSP		PE
2 Door Position Switch	By Security Contractor		OT

Set: 7.0

Doors: H101A

3 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Rim Exit Device, Exit Only	8810 EO	US32D	SA
1 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Gasketing	2891AS TKSP		PE
1 Rain Guard	346C TKSP		PE
1 Sweep	315CN TKSP		PE
1 Door Position Switch	By Security Contractor		OT

Set: 8.0

Doors: CR04A, D105B

3 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Surface Closer	CPS7500	689	NO
1 Threshold	171AK MSES25SS		PE
1 Gasketing	2891AS TKSP		PE
1 Rain Guard	346C TKSP		PE
1 Sweep	315CN TKSP		PE
1 Door Position Switch	By Security Contractor		OT

Set: 9.0

Doors: H104B

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
2 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Passage Latch	ML2010 NSP	626	RU
1 Surface Closer	7500	689	NO
2 Wall Stop	406	US32D	RO
1 Concealed Automatic Door Bottom			

Set: 10.0

Doors: A106B, CR001, CR003, CR04B, D106, E102B, E104, F109, G101A

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT
1 Concealed Automatic Door Bottom	(Door's D106, E102B, G101A Only)		

Notes: Door normally closed and locked.

Entry by valid credential or manual key override.

Always free egress.

Upon loss of power, door remains locked.

Set: 11.0

Doors: A105A

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
1 Surface Closer	CPS7500	689	NO
1 Gasketing	S88BL		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT

1 Power Supply	By Security Contractor	OT

Notes: Door normally closed and locked.
Entry by valid credential or manual key override.
Always free egress.
Upon loss of power, door remains locked.

Set: 12.0

Doors: A101, A102, A103, A104, B102, B103, B104, B105, B106

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Notes: Door normally closed and locked.
Entry by valid credential or manual key override.
Always free egress.
Upon loss of power, door remains locked.

Set: 13.0

Doors: A107A, A107B

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Rim Exit Device, Classroom	12 70 8813 ETL	US32D	SA
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Concealed Automatic Door Bottom			

Set: 14.0

Doors: A105B, E103, E105A, H102B

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU

1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO
1 Concealed Automatic Door Bottom	(Door A105B & H102B Only)		

Set: 15.0

Doors: E108

3 Hinge, Full Mortise, Hvy Wt	T4A3786 5" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO

Set: 16.0

Doors: H101B

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Rim Exit Device, Storeroom	8804 ETL	US32D	SA
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO
1 Concealed Automatic Door Bottom			

Set: 17.0

Doors: E102A, G101B, H107

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Passage Latch	ML2010 NSP	626	RU
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO
1 Concealed Automatic Door Bottom	(Door E102A only)		

Set: 18.0

Doors: C102A, E109A, E110, F103, F104, H105A, H106, J101, J104

3 Hinge, Full Mortise, Hvy Wt	T4A3786 5" x 4-1/2" (NRP as Required)	US26D	MK
1 Passage Latch	ML2010 NSP	626	RU
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO

Set: 19.0

Doors: C101, C103

3 Hinge, Full Mortise, Hvy Wt	T4A3786 5" x 4-1/2" (NRP as Required)	US26D	MK
1 Passage Latch	ML2010 NSP	626	RU
1 Surf Overhead Stop	10-X36	652	RF
1 Surface Closer	7500	689	NO

Set: 20.0

Doors: B112, D108

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Privacy Lock	ML2030 NSP M19V	626	RU
1 Surface Closer	7500	689	NO
1 Wall Stop	406	US32D	RO

Set: 21.0

Doors: B111B

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	By Security Contractor		OT
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT
1 Push Button Release	By Security Contractor		OT
1 Concealed Automatic Door Bottom			

Notes: Door normally closed and locked.
Entry by valid credential or manual key override.
Always free egress.
Upon loss of power, door remains locked.

Set: 22.0

Doors: D105C, G102

1 Hardware

By Door and Frame Manufacturer

OT

END OF SECTION 087100

SECTION 08 71 00B

DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during

the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Twenty five years for manual overhead door closer bodies.

3. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.

- b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
- 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
- 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
- 5. Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).

2.3 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
 - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 - 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 - 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - 5. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
1. Threaded mortise cylinders with rings and cams to suit hardware application.
 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 4. Tubular deadlocks and other auxiliary locks.
 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 6. Keyway: Match Facility Restricted Keyway.
- C. Interchangeable Cores: Provide small format interchangeable cores as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Keying System: Each type of lock and cylinders to be factory keyed.
1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- E. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
 4. Permanent Control Keys (where required): Two (2).
- F. Construction Keying: Provide temporary keyed construction cores.
- G. Key Registration List (Bitting List):
1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).

- c. Telkee (TK).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 - 1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. dormakaba Best (BE) - 45H Series.

2.7 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 - 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 - 4. Dustproof Strikes: BHMA A156.16.

2.8 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
 - 1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 - 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. LCN Closers (LC) - 4040 Series.
 - c. Norton Door Controls (NO) - 7500 Series.

2.9 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
1. Manufacturers:
 - a. Ives (IV).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.10 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).
 - 4. Zero (ZE).

2.11 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.12 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
 - 2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.

- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. RU - Corbin Russwin
3. AW - Arrow Lock
4. OT - Other
5. HS - HES
6. RO - Rockwood
7. NO - Norton
8. PE - Pemko

Hardware Sets

Set: 1.0

Doors: E-2, E-23, E-23.1, E-23.2

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Storeroom Lock	ML2057 NSP CT7SD	626	RU
1 Electric Strike	1006CLB-LBSM	630	HS
1 SMART Pac Bridge Rectifier	2005M3		HS
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE
1 Door Position Switch	By Security Contractor		OT
1 Card Reader	By Security Contractor		OT
1 Power Supply	By Security Contractor		OT

Set: 2.0

Doors: E-2.1

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2" (NRP as Required)	US26D	MK
1 Passage Latch	ML2010 NSP	626	RU
1 Wall Stop	406	US32D	RO
1 Gasketing	S88BL		PE

Set: 3.0

Doors: E-4, E-6

1 Indicator Deadbolt	E50	US26D	AW
1 Push Plate	70C-RKW	US32D	RO
1 Pull Plate	111x70C	US32D	RO
1 Balance of Hardware	Existing to Remain		OT

Set: 4.0

Doors: E-24.1

1 Surface Closer	7500	689	NO
1 Balance of Hardware	Existing to Remain		OT

END OF SECTION

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SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Exterior Windows.
 - 2. Exterior Doors.
 - 3. Interior Doors.
 - 4. Interior acoustic windows

1.2 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Design Wind Loads for Exterior Conditions: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2- Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
 - 1) Basic Wind Speed: 120 mph (3-Second Gust)
 - 2) Importance Factor: 1.0
 - 3) Exposure Category: B.
 - b. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 60 seconds or less.
 - c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at

design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.

- 1) For monolithic-glass lites heat treated to resist wind loads.
 - 2) For insulating glass.
 - 3) For laminated-glass lites.
 - d. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
 - e. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
1. For laminated-glass lites, properties are based on products of construction indicated.
 2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - a. U-Factors: NFRC 100 expressed as Btu/sq. ft. x h x deg F.
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.
- E. Impact Resistance: In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E 1996 and ASTM E 1886 referenced herein as follows:
1. Glazed openings located within 30 feet of grade shall meet the requirements of the large missile test of ASTM E 1996.

1.3 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: For the following products, in the form of 12-inch-square Samples for glass.
- C. Each type of tempered safety glass
- D. Each type of laminated glass with interlayer.
- E. Insulating glass for each designation indicated.
- F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- C. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.
- D. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
- E. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
- F. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
- B. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.
 - 1. Use Saflex-HP laminated insulated units for insulated glass.
 - 2. Use Pilkington Pyrostop glass for all fire-rated doors and windows.

2.2 GLASS PRODUCTS

- A. Heat-Treated Float Glass, General Properties: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
 - 1. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 - 2. For uncoated glass, comply with requirements for Condition A.
 - 3. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 - 4. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.
- B. Exterior Windows: Insulated / Laminated Glass units: ASTM C 1172, ASTM E 1866, ASTM E 1996 (Hurricane Resistant). The exterior window glass shall consist of one outboard pane and one inboard pane, with a hermetically sealed space in between, and total nominal thickness of 1-1/2", as follows:
 - 1. Outboard Pane: one-quarter inch clear thick tempered glass.
 - 2. Inboard Pane: Laminated glass consisting of the following: Two layers of one-quarter inch thick heat-strengthened glass with .030" thick thick Saflex-HP interlayer in between. Clear glass unless otherwise specified by Owner.

3. Saflex Interlayer, General Properties: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation. Interlayer Color: Lag RB17 654400.
 - a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
 4. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.
- C. Exterior doors lites: Insulating-Glass units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 3. Sealing System: Dual seal, with primary and secondary sealants as follows:
 - a. Manufacturer's standard sealants.
 4. Spacer Specifications: Manufacturer's standard spacer material and construction.
 - a. Spacer Material: Aluminum with mill or clear anodic finish.
 - b. Desiccant: Molecular sieve or silica gel, or blend of both.
 - c. Corner Construction: Manufacturer's standard corner construction.
- D. Interior Non-fire-rated door lites: ¼" thick clear tempered safety glass.
- E. Interior 90-minute Fire-Rated door glass lites: Pilkington Pyrostop glass, thickness as specified by manufacturer.
- F. Interior 90-minute Fire-Rated window glass: Pilkington Pyrostop glass, thickness as specified by manufacturer.

2.3 GLAZING GASKETS

- A. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
1. EPDM.
 2. Silicone.
 3. Thermoplastic polyolefin rubber.
 4. Any material indicated above.

2.4 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.5 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION

SECTION 08 91 19

FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

- D. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Drainable-Blade Louver L-1:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametco Manufacturing Corporation.
 - b. Construction Specialties, Inc.
 - c. Greenheck Fan Corporation.
 - d. Maxam Metal Products.
 - e. Nystrom, Inc.
 - 2. Louver Depth: 6 inches.
 - 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
 - 4. Mullion Type: Exposed.
 - 5. Louver Performance Ratings:
 - a. Free Area: Not less than 8.0 sq. ft. for 48-inch-wide by 48-inch-high louver.
 - b. Point of Beginning Water Penetration: Not less than 1100 fpm.
 - c. Air Performance: Not more than 0.16 inch wg (39.7 Pa) static pressure drop at 990-fpm (5-m/s) free-area intake velocity.
 - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

- A. General: Provide screen at each louver except those located in mechanical equipment screen wall.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert.

D. Louver Screening for Aluminum Louvers:

1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Post installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.6 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide extended sills for recessed louvers.

- F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: Match color of metal wall panels as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 09 21 16

COLD FORM FRAMING AND GYPSUM BOARD SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Related Work Specified Elsewhere:
 - 1. Section 09 91 26 – Building Painting

1.2 QUALITY ASSURANCE

- A. Applicable Standards: Conform to the following:
 - ASTM C 36: Specification for Gypsum Wallboard
 - ASTM C 442: Specification for Gypsum Backing Board
 - ASTM C 475: Specification for Joint Treatment Materials for Gypsum Wallboard Construction
 - ASTM C 630: Specification for Water-Resistant Gypsum Backing Board
 - ASTM C 645: Specification for Nonload (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board
 - ASTM C 646: Specification for Steel Drill Screws for the Application of Gypsum Sheet Material to Light-Gage Steel Studs
 - ANSI A97.1: American Standard Specification for the Application and Finishing of Gypsum Wallboard
- B. Tolerances: Do not exceed a variation of 3/16 inch in eight feet and 1/8 inch in four feet from plumb, level and flat in all directions. Do not exceed 1/16 inch offset of planes at joints between panels. Shim panels as necessary to comply with tolerances.

1.3 SUBMITTALS

- A. System Selection: Submit name of system selected for use to the Owner.
- B. Samples: Submit sample of each item of material specified.
- C. Shop Drawings: Indicate on shop drawings the following:
 - 1. Metal stud system.
 - 2. Metal furring channels.
 - 3. Drywall systems.
 - 4. Location and type of fasteners.
 - 5. Sealant location.

1.4 PRODUCT DELIVERY AND STORAGE

- A. Delivery: Deliver materials to the Project site in original, unopened packages, containers or bundles bearing the manufacturer's name and brand.

- B. Storage: Keep all materials dry; protect from weather; and store under cover, above the ground and away from sweating walls or other damp surfaces. Store gypsum on level surfaces and stack flat to avoid damage to edges, ends and surfaces.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Manufacturer: Select materials and systems from same manufacturer. Select from one of the following:
 - 1. Georgia-Pacific Bestwall Gypsum Division
 - 2. National Gypsum Company
 - 3. United States Gypsum Company
- B. Standard Gypsum Drywall:
 - 1. Nonrated: Install at non-rated interior partitions.
 - a. 5/8" Face Layer: ASTM C 36, with long edges tapered.
 - 2. Fire-Rated: Install at fire-rated interior partitions.
 - a. 5/8" Face Layer: ASTM C 36, Type SCX, with long edges tapered.
- C. Mold-Resistant Gypsum Drywall, 5/8" thick: ASTM D 3273.
 - 1. Install on the interior finish side of all exterior walls, including all returns at doors and windows.
- D. Water Resistant Gypsum Drywall, 5/8" thick: ASTM C 630.
 - 1. Install on north and west walls of Breakroom, all walls of Janitor Closet, and as indicated on Drawings.
- E. Durock Cement Board, USG, 5/8" thick x 48" cementitious backer units complying with ANSI A118.9, of thickness and width indicated below, and in maximum lengths available to minimize end-to-end butt joints.
 - 1. Install behind ceramic tile in Toilet Rooms.
- F. Exterior Gypsum Sheathing: 5/8" thick Densglass gold Exterior sheathing.
 - 1. Install over the face of the exterior metal studs.
- G. Gypsum Drywall Finishing Products:
 - 1. Tape: Reinforced, perforated fiber tape conforming to ASTM C 475.
 - 2. Joint Compound: Ready-mixed joint compound for both bedding and finishing joints, conforming to ASTM C 475.
- H. Shaftwall Studs and Liner: 6" 18 gage studs and 1" thick, square edge gypsum board.
 - 1. Install around fans for noise enclosure in Extruder Room.
- I. Accessories:
 - 1. Corner Beads: Galvanized steel, equal to U. S. Gypsum Dur-A-Bead No. 103. Install on all outside corners.

2. LC-bead with both face and back flanges; face flange formed to receive joint compound. Install for edge trim unless otherwise noted.
 3. Miscellaneous Metal Trim: Galvanized steel, equal to U. S. Gypsum 200 Series.
 4. Control Joints: One-piece control joint formed with V-shaped slot and removable strip covering slot opening. Roll-formed zinc, equal to U. S. Gypsum No. 093.
 5. Staples: Galvanized steel, 16 gage, 9/16 inch long.
- J. Sealant:
1. Acoustical Sealant: Nondrying, non-shrinking, non-migrating sealant recommended by drywall manufacturer to provide indicated STC ratings.
 2. Water Resistant Sealant: Type recommended by drywall manufacturer to seal raw cut edges and screw heads of water-resistant drywall.
- K. Sound Attenuation Insulation: See 07 21 16 – Blanket Insulation.
- L. Metal Studs, Metal Runners and Metal Furring Channels: ASTM C 645, galvanized in accordance with Federal Specification QQ-S-775, Class d or e.
1. Exterior Metal Studs: 6", 12 gage, 600S200-68 channel type studs at 12" o.c. Install horizontal bridging at maximum 48" o.c. – use 16 gage "Spazzer 5400 Bar" system by Dietrich, or approved equal.
 2. Interior Metal Studs: 18 gage channel type at 16" o.c., unless otherwise noted on Drawings. Install horizontal bridging as directed by stud manufacturer, with three rows of horizontal bridging at one-quarter points at all full height partitions - use 20 gage "Spazzer 9200 Bar" system by Dietrich, or approved equal.
 3. Metal Runners: Channel type, 1-1/4 inch leg, same gage as studs.
 4. Metal Furring Channels: 20 gage, face width 1-3/8 inches, depth 7/8 inch.
- M. Fasteners:
1. For Metal Runners:
 - a. To Concrete floor (at Interior partitions): Concrete stub nails, No. 8 case-hardened, 3/4 inch long.
 - b. To Concrete floor (at Exterior walls): As shown on drawings.
 - c. To Structural Members: Machine bolts, size as required.
 2. For Metal Studs:
 - a. To Metal Runners (at interior partitions): Self-drilling, self-tapping pan head screws, 3/8 inch long.
 - b. To Metal Runners (at exterior walls): As shown on Drawings.
 3. For Gypsum Drywall to Metal Studs, Metal Furring Channels and Ceiling Suspension System: Self-drilling, self-tapping bugle head screws conforming to ASTM C 646, length as specified.
- N. Grout: Joint compound of type recommended by drywall manufacturer.
- O. Insulation (furnished under Section 07 21 16):
1. Preformed glass or mineral fiber batt, Type I, without membrane, thickness and R-value where indicated on Drawings, by Johns Manville or Owens Corning.
 2. Thermafiber: install Thermafiber insulation wherever insulation is called for in fire-rated partitions.

PART 3 EXECUTION

3.1 PREPARATORY WORK

- A. During the period of drywall installation and joint finishing, provide adequate ventilation to eliminate excessive moisture buildup, and in cold weather, maintain a uniform temperature range of 55 to 70°F in the installation area.

3.2 ERECTION OF METAL SYSTEMS

- A. General: Install stud system in accordance with manufacturer's specifications. At locations where any fixture or accessory occurs on a metal stud partition, position metal runners horizontal between studs and anchor with screws. Spot grout jamb anchor clips at door frames.
- B. Metal Runners: Accurately align partitions to layout. Align floor and ceiling runners to assure plumb wall.
 - 1. Floor Runners: Anchor floor runners to concrete floor with concrete stub nails spaced two inches from each end and 24 inches on centers in remainder of space.
 - 2. Ceiling Runners:
 - a. Anchor ceiling runners to concrete ceiling slab with concrete stub nails spaced two inches from each end and 24 inches on centers in remainder of space.
 - b. Anchor ceiling runners to suspended grid system with screws located a maximum of 24 inches on centers.
 - c. Anchor ceiling runners to structural steel framing with machine bolts. To obtain necessary structural stability in partitions above suspended ceilings, provide auxiliary steel framing securely anchored to structure and partitions.
- C. Metal Studs:
 - 1. Position studs vertically in the runners. Anchor studs located adjacent to door openings, partition intersections and corners to runner flanges with screws through each stud flange and runner flange. When necessary, splice studs by nesting, lapping studs a minimum of eight inches and attaching flanges together with two screws in each flange.
 - 2. Double studs at door frames and control joints. Locate a single stud no more than six inches from door frame jambs, abutting partitions, partition corners and control joints. Screw attach studs to jamb and head anchor clips of each door frame.
- D. Header Sections: Fabricate a header section over door frames as detailed on drawings. Slit flanges and bend web to overlap adjacent vertical studs. Anchor header to studs with two screws per stud.
- E. Metal Furring Channels:
 - 1. Install metal furring channels vertically. Anchor furring channels with concrete stub nails spaced twelve inches on centers staggered through alternate wing flanges of the furring channel. Nest channels eight inches at splices and anchor

- with two concrete stub nails in each wing. Space furring channels not greater than one inch from interior and exterior corners and openings. Position furring channels horizontally at drywall end joints.
 - 2. At locations where fixtures or accessories occur on a metal furring channel system, position furring channels horizontally and anchor as specified above.
- F. Deflection Track: Manufacturer's standard top runner design to prevent cracking of gypsum board applied to interior partitions from deflection of the structure above. Fabricated from steel sheet complying with ASTM A 653 or ASTM A 568. Thickness as indicated for studs, and width to accommodate depth of studs, and of the following configuration:
 - 1. Top Runner with Slotted Flanges: 2-1/2-inch- (63.5-mm-) deep flanges with slots 1 inch 25.4 mm) o.c.
 - a. Acceptable Products:
 - 1) SLP-TRK; Metal-Lite, Inc.
 - 2) Fire Track Corporation.
- G. Steel Flat Strap and Backing Plates: Steel sheet for blocking and bracing complying with ASTM A 653 or ASTM A 568, length and width as indicated on wall types drawing, and with a minimum base metal (uncoated) thickness as follows:
 - 1. Thickness: 14 gage minimum, unless otherwise indicated.
 - 2. Height: Not less than 6".

3.3 INSTALLATION OF GYPSUM DRYWALL SYSTEMS

- A. General:
 - 1. Install all gypsum board materials and accessories in accordance with the "USG gypsum Construction handbook."
 - 2. Install all materials in accordance with ANSI A97.1 and the latest printed directions or specifications of the manufacturer.
 - 3. Power-drive screws with an electric screwdriver so screw heads provide a slight depression below surface of gypsum drywall without breaking paper face.
 - 4. Cut gypsum drywall neatly to fit around all outlets, switchboxes and other openings. Cut gypsum drywall for scoring or breaking, or by sawing, working from face side. Scribe gypsum drywall neatly where same meets projecting surfaces.
 - 5. Provide fire ratings as required.
- B. Ceiling: Apply gypsum drywall with long dimension at right angles to the metal runners. Position end joints over runners staggered in adjacent rows. Neatly fit abutting ends and edges, but do not force together. Fasten gypsum drywall to each metal runner with one inch long screws spaced twelve inches on centers in the field of the board and along abutting ends and edges.
- C. Partitions: Apply drywall with long dimensions parallel to framing members, with all abutting ends and edges occurring over surfaces of framing members. Use drywall of maximum practical length to minimize end joints. Stagger end joints. Neatly fit abutting ends and edges. Locate drywall joints at openings so that no end joint will align with edges of opening. Bring boards into contact, but do not force into place. Arrange joints

on opposite sides of partitions so as to occur on different studs. Space fasteners at least 3/8 inch from ends and edges of drywall.

1. Single Layer Thickness on Metal Studs: Space one inch long screws twelve inches on centers in field of boards and eight inches on centers along vertical abutting edges.
2. Double Layer Thickness on Metal Studs: Offset joints of face layer from joints of base layer.
 - a. Base Layer: Space 1 inch long screws 16 inches on centers in the field of boards and along vertical abutting edges.
 - b. Face Layer: Offset screws for face layer from those of base layer. Space 1-5/8 inch long screws 16 inches on centers in field of boards and along vertical abutting edges.

D. Accessories:

1. Corner Beads: Install corner beads at all exterior angles. Fasten corner bead with staples nine inches on centers on both flanges along entire length of bead.
2. Metal Trim: Install metal trim around openings, where gypsum drywall terminates and at other dissimilar material. Fasten with screws or staples twelve inches on centers.
3. Control Joints: Break panel behind joint and back by double framing members and a two inch wide gypsum panel strip. Attach control joint to face layer with staples spaced six inches on centers on both flanges along entire length of joint.

3.4 INSTALLATION OF INSULATION

- A. Firmly press blankets in place against back of gypsum drywall. Secure each blanket in place with staples located in center and in each corner. Apply staples through minimum two inch square heavy paper washers, or staple over 6d nails laid flat on the blanket. Maintain air space between blankets and back surface of one partition face. Tightly butt ends of blankets leaving no voids.
- B. See Blanket Insulation specification section 07 21 16 for additional installation instructions.

3.5 INSTALLATION OF ACOUSTICAL SEALANT

- A. Apply acoustical sealant to provide sound ratings as required. Apply sealant with an air pressure-activated or hand caulking gun. Fill all voids at floor, wall and ceiling where partition abuts dissimilar construction and seal perimeter of all cutouts and openings.

3.6 GYPSUM DRYWALL FINISHING

- A. Joint and Angle Treatment:
 1. Apply joint compound to channel formed by tapered edges of the gypsum drywall panels. Fill channel completely, position tape and wipe down. Leave sufficient joint compound under tape to provide proper bond. Follow immediately with a thin skim coat to embed tape, but not to function as a second coat. At all interior angles, fold and embed tape properly to provide a true angle. Joint compound must thoroughly dry prior to application of second coat.

2. Apply second coat of joint compound, and feather approximately two inches beyond edges of first coat. Allow joint compound to thoroughly dry prior to application of finish coat. Do not apply second coat of joint compound to interior angles.
 3. Spread finish coat evenly over and extend slightly beyond second coat on all joints and feather to a smooth uniform finish. Do not allow finish joint to protrude beyond plane of the surface of the tapered edge. Apply joint compound at taped angles to provide a true angle.
 4. Where necessary sand between coats of joint compound. Following the final application of joint compound, sand to provide a smooth surface.
- B. Finishing Fastener Depressions: Apply joint compound to fastener depressions. Follow with a minimum of two additional coats of joint compound, leaving all depressions level with the plane of the surface. Allow each coat to thoroughly dry prior to application of following coat. Sand finish coat as necessary for a smooth surface.
- C. Finishing Gypsum Drywall Accessories:
1. Apply joint compound and properly feather cut from ground to plane of surface. Allow joint compound to thoroughly dry prior to application of second coat of joint compound.
 2. Apply second coat of joint compound in same manner as first coat, extending joint compound slightly beyond onto face of gypsum drywall. Allow joint compound to thoroughly dry prior to application of finish coat.
 3. Apply finish coat of joint compound, extending compound slightly beyond the second coat and properly feathering from ground to plane of surface. Sand finish coat as necessary for a smooth surface.
 4. Level of Gypsum Board Finish: Provide Level 4 for gypsum board surfaces per GA-214.

END OF SECTION

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SECTION 09 30 00

TILING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Ceramic Tile for walls.
 - 2. Ceramic porcelain tile for floors.
 - 3. Solid polymer thresholds installed as part of tile installations.
 - 4. Crack-suppression membrane for thin-set tile installations.
 - 5. Metal edge strips installed as part of tile installations.
- B. Related Sections include the following:
 - 1. Section 07 90 00 - Joint Protection for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

- A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
- B. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).
- C. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

1.4 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
 - 1. Level Surfaces: Minimum 0.6.
 - 2. Step Treads: Minimum 0.6.
 - 3. Ramp Surfaces: Minimum 0.8.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

1.6 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
- B. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Waterproofing.
 - 2. Joint sealants.
 - 3. Metal edge strips.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store liquid latexes and emulsion adhesives in unopened containers and protected from freezing.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
 - 2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
 - 1. As selected by Architect from manufacturer's full range.
- D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. Acceptable Manufacturers:
 - 1. American Olean
 - 2. Dal-Tile Corp.
 - 3. Crossville Porcelain Stone
- B. Tile: A137.1, Standard Grade, back grooved, cushion edge. Final colors, sizes, and finishes shall be selected by Owner from manufacturer's entire range of products.
 - 1. Unglazed Porcelain Floor Tile: Dust-pressed porcelain.
 - a. Size: 12" x 12"
 - b. Thickness: 5/16"
 - c. Face: Cross-Slate Texture
 - 2. Glazed Ceramic Wall Tile: Dust-pressed method.
 - a. Size: 4-1/4" x 4-1/4"; 2" x 2" @ accent bands
 - b. Thickness: 1/4 inch
 - c. Finish: Gloss glazed
 - 3. Trim:
 - a. In-corners coved.
 - b. Out-corners: Bullnose.
 - c. Base course: To match wall tile. (4-1/4" x 4-1/4")
 - d. Jambs: Bullnose
 - e. Miscellaneous Shapes: Caps, stops, returns, trimmers, moldings, angles, and other shapes required to produce a finished installation.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch or less, and finish bevel to match face of threshold.
- B. Solid Polymer Thresholds: Made from homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without precoated finish.
 - 1. Available Manufacturers:
 - a. Avonite, Inc.
 - b. DuPont Polymers.
 - c. Formica Corporation.
 - d. Nevamar; International Paper; Decorative Products Division.
 - e. Swan Corporation (The).
 - f. Wilsonart International; Div. of Premark International, Inc.

2.5 CRACK-SUPPRESSION MEMBRANES FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10.
 - 1. Available Product: National Applied Construction Products, Inc.; Strataflex.

- B. Latex-Portland Cement Product: Flexible mortar consisting of cement-based mix and acrylic-latex additive.
 - 1. Available Products:
 - a. Boiardi Products Corporation; Elastiment 323.
 - b. MAPEI Corporation; PRP 315.
 - c. Southern Grouts & Mortars, Inc.; Southcrete 1100.
 - d. TEC Specialty Products Inc.; TA-324, Triple Flex.

2.6 SETTING AND GROUTING MATERIALS

- A. Available Manufacturers:
 - 1. Atlas Minerals & Chemicals, Inc.
 - 2. Boiardi Products Corporation.
 - 3. Bonsal, W. R., Company.
 - 4. Bostik.
 - 5. C-Cure.
 - 6. Custom Building Products.
 - 7. DAP, Inc.
 - 8. Jamo Inc.
 - 9. LATICRETE International Inc.
 - 10. MAPEI Corporation.
 - 11. Southern Grouts & Mortars, Inc.
 - 12. Summitville Tiles, Inc.
 - 13. TEC Specialty Products Inc.
- B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:
 - 1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site.
 - 2. Prepackaged dry-mortar mix combined with acrylic resin liquid-latex additive.
 - a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

2.7 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7.
 - 1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other

nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

1. Available Products:
 - a. Dow Corning Corporation; Dow Corning 786.
 - b. GE Silicones; Sanitary 1700.
 - c. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
 - d. Tremco, Inc.; Tremsil 600 White.

2.8 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.
- C. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
 1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F per ASTM D 87.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- E. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints that does not change color or appearance of grout.
 1. Available Products:
 - a. Bonsal, W. R., Company; Grout Sealer.
 - b. Bostik; CeramaSeal Grout Sealer.
 - c. C-Cure; Penetrating Sealer 978.
 - d. Custom Building Products; Grout and Tile Sealer.
 - e. Jamo Inc.; Penetrating Sealer.
 - f. MAPEI Corporation; KER
 - g. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
 - h. Summitville Tiles, Inc.; SL-15, Invisible Seal Penetrating Grout and Tile Sealer.

2.9 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.

- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
 - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Provide concrete substrates for tile floors installed with adhesives that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
 - 1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
 - 2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- F. Lay out tile wainscots to next full tile beyond dimensions indicated.
- G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 7.
- H. Grout tile to comply with requirements of the following tile installation standards:
 - 1. For ceramic tile grouts (sand-portland cement; dry-set, commercial portland cement; and latex-portland cement grouts), comply with ANSI A108.10.
 - 2. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
 - 3. For chemical-resistant furan grouts, comply with ANSI A108.8.

3.4 CRACK-SUPPRESSION MEMBRANE INSTALLATION

- A. Install crack-suppression membrane to comply with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.

3.5 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
 - 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
 - a. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Joint Widths: Install tile on floors with the following joint widths:
 - 1. Tile: Per manufacturer's recommendations.

- C. Thresholds: Install stone or polymer thresholds at junctions between tile and adjacent floor finishes. Set in same type of setting bed as abutting field tile, unless otherwise indicated.
 - 1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent nontile floor finish.
- D. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.
- E. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.6 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Ceramic Tile: 1/16 inch.

3.7 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
 - 3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.8 FLOOR TILE

- A. Install interior floor tile installation on waterproof crack-resistant membrane over concrete; thin-set mortar; TCA F122 and ANSI A108.5.
 - 1. Tile Type: Porcelain Ceramic tile.
 - 2. Thin-Set Mortar: Latex-portland cement mortar.

3.9 WALL TILE INSTALLATION SCHEDULE

- A. Install interior wall tile installation over Durock board per drawings; thin-set mortar; TCA W243 and ANSI A108.5.
 - 1. Tile Type: Ceramic tile.
 - 2. Thin-Set Mortar: Latex-portland cement mortar.
 - 3. Grout: Standard sanded cement grout.

END OF SECTION

SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustical ceiling panels.
 - 2. Exposed grid suspension system.
 - 3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings.
 - 4. Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - 4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - 5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - 6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
 - 7. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 8. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
 - 9. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems.
 - 10. ASTM E 1264 Classification for Acoustical Ceiling Products.
 - 11. ASTM E 1477 Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
 - 12. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - 13. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Material.
 - 14. UL2043 Fire Tests for Heat and Visible Smoke Release for Discrete Products and their Accessories in Air Handling Spaces

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.
- B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.
- C. Shop Drawings: Layout and details of acoustical ceilings. Show locations of items which are to be coordinated with, or supported by the ceilings.
- D. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.
- E. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
- B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
 - 1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.
 - a. Flame Spread: 25 or less
 - b. Smoke Developed: 50 or less
- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.6 PROJECT CONDITIONS

- A. Space Enclosure:
 - 1. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.

1.7 WARRANTY

- A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to:
 - 1. Acoustical Panels: Sagging and warping
 - 2. Grid System: Rusting and manufacturer's defects
- B. Warranty Period:
 - 1. Acoustical Panels: One (1) year from date of substantial completion.
 - 2. Grid: Ten years from date of substantial completion.
- C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.8 MAINTENANCE

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
 - 1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 5.0 percent of amount installed.
 - 2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Ceiling Panels:
 - 1. Armstrong World Industries, Inc.

- B. Acoustical Panels Type ACT-1 (all areas except Toilet Rooms & Jan. Closet):
1. Surface Texture: Medium
 2. Pattern: Cortega Second Look II.
 3. Composition: Mineral Fiber
 4. Color: White
 5. Size: 48in X 24in X 3/4in
 6. Edge Profile: Angled Tegal (2766 for use with 15/16" tees; 2775 for use with 9/16" tees).
 7. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton, 0.55.
 8. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified with UL label on product carton, 30.
 9. Flame Spread: ASTM E 1264; Class A (UL).
 10. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.82.
 11. Dimensional Stability: Standard.
- NOTE: OWNER SHALL VERIFY CEILING TILE SELECTION PRIOR TO SUBMITTING SAMPLES FOR APPROVAL.
- C. Acoustical Panels Type ACT-2 (Toilet Rooms & Jan. Closet):
1. Surface Texture: Fine
 2. Pattern: Clean Room Mylar, non-perforated (1716 for use with 12/16" tees). Scrubbable and soil resistant.
 3. Composition: Mineral Fiber
 4. Color: White
 5. Size: 48in X 24in X 3/4in
 6. Edge Profile: Square.
 7. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton, 0.55.
 8. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified with UL label on product carton, 30.
 9. Flame Spread: ASTM E 1264; Class A (UL).
 10. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.80.
 11. Dimensional Stability: Standard.
- NOTE: OWNER SHALL VERIFY CEILING TILE SELECTION PRIOR TO SUBMITTING SAMPLES FOR APPROVAL.

2.2 SUSPENSION SYSTEMS

- A. Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are Heavy Duty double-web steel construction with type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished galvanized steel (aluminum or stainless steel) in baked polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).
1. Structural Classification: ASTM C 635 and ASTM C-636 to meet the requirements for seismic exposure category "C".
 2. Color: White.

- 3. Acceptable Product:
 - a. For Cortega Second Look II: 15/16" standard tee, or 9/16" Suprafine Exposed Tee as selected by Owner, and as manufactured by Armstrong World Industries, Inc.
 - b. For Clean Room Mylar: 15/16" standard tee as manufactured by Armstrong World Industries, Inc.
- B. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
- C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least three times design load, but not less than 12 gauge.
- D. Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, including light fixtures, that fit type of edge detail and suspension system indicated. Provide moldings with exposed flange of the same width as exposed runner.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.
- B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
 - 1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

- A. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.
- B. When attaching coax cables to the antenna panels, support the face of the face of the panel.

- C. Suspend main beam from overhead construction with hanger wires spaced 4-0 on center along the length of the main runner. Install hanger wires plumb and straight.
- D. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.
- E. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.
- F. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

3.4 ADJUSTING AND CLEANING

- A. Replace damaged and broken panels.
- B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09 65 01

RESILIENT FLOORING AND BASE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The work of this Section includes:
 - 1. Rubber tile flooring
 - 2. Rubber wall base
 - 3. Responsibilities, preparation/installation
- B. Related Section:
 - 1. Section 09 65 01 – Resilient Flooring Accessories
- C. References (Industry Standards)
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
 - b. ASTM D2240 Standard Test Method for Rubber Property - Durometer Hardness
 - c. ASTM D3389 Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform, Double-Head Abrader)
 - d. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - e. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - f. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 - g. ASTM E2180 Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) in Polymeric or Hydrophobic Materials
 - h. ASTM F150 Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
 - i. ASTM F511 Standard Test Method for Quality of Cut (Joint Tightness) of Resilient Floor Tile
 - j. ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
 - k. ASTM F970 Standard Test Method for Static Load Limit
 - l. ASTM F1344 Standard Specification for Rubber Floor Tile
 - m. ASTM F1482 Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
 - n. ASTM F1514 Standard Test Method for Measuring Heat Stability of Resilient Flooring by Color

- o. ASTM E1745 Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- p. ASTM F1859 Standard Specification for Rubber Sheet Floor Covering Without Backing
- q. ASTM F1860 Standard Specification for Rubber Sheet Floor Covering With Backing
- r. ASTM F1861 Standard Specification for Resilient Wall Base
- s. ASTM F2055 Standard Test Method for Size and Squareness of Resilient Floor Tile by Dial Gage Method
- t. ASTM F2169 Standard Specification for Resilient Stair Treads
- u. ASTM F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- v. ASTM F2420 Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood
- w. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- 2. National Fire Protection Association (NFPA)
 - a. NFPA 25 Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Energy Source
 - b. NFPA 258 Test Method for Specific Density of Smoke Generated by Solid Materials

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data sheets, installation guide, and maintenance guide for each material proposed for use (available on www.nora.com/us).
- B. Submit documents which describe proposed products and manufacturer's recommendations for installation. Submit with such documents as tile manufacturer's certifications that proves that products supplied for tile installation comply with local regulations controlling use of volatile organic compounds.
- C. Samples: Submit two 3 inch by 3 inch samples of each product, in color specified, for verification. The degree product requires two 6 inch by 6 inch samples.
- D. MSDS (Material Safety Data Sheets) should be submitted for all adhesives used: Nora® membrane, primer, patch, leveler, heat weld rod, cold weld, liquid wax and cleaning agents. These are available at www.nora.com/us.

1.3 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Color Matching: Provide resilient flooring products, including wall base and accessories, from one manufacturer to ensure color matching.

- 2. Manufacturer capable of providing technical training and field service representation.
- B. Installer Qualifications: Installer shall be Nora approved for the requirements of the project or INSTALL (International
- C. Standards & Training Alliance) resilient certified for the requirements of the project. Each installer assigned to the project shall also have a minimum of three years' experience.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project site in manufacturer's original unopened containers, each bearing names of product and manufacturer in labeled packages. Include shipping and handling instructions. Store and handle in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations. Maintain ambient storage temperature of 50°F to 90°F.
- B. Deliver materials sufficiently in advance of installation to condition materials to the required temperature prior to installation.
- C. Store tile on flat surfaces. Move tile and installation accessories into spaces where they will be installed at least 48 hours in advance of installation.

1.5 PROJECT CONDITIONS

- A. Maintain temperature and humidity at service levels or 68° F (20° C), $\pm 5^\circ$ F (3° C), and 50% RH $\pm 10\%$ in areas to receive resilient flooring. Specified temperature shall be maintained at least 48 hours before, during, and 72 hours after installation.
- B. Do not install tile until they are at same temperature as space where they are to be installed.
- C. Close spaces to traffic during installation.

1.6 WARRANTY

- A. Provide manufacturer's standard one-year warranty against defects in manufacturing and workmanship of all flooring products. Provide manufacturer's warranty as specified under each product as applicable, including limited wear, defect and conductivity.

1.7 EXTRA MATERIALS

- A. Furnish full size units equal to 2 percent of quantity of resilient flooring installed as extra materials. Properly label and package extra materials. Deliver to owners designated storage area.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide resilient flooring by Nora Systems, Inc., 9 Northeastern Blvd., Salem, NH 03079; telephone 800-332-NORA, or 603-894-1021; fax 603-894-6615.
- B. The manufacturer shall offer a construction waste take back program for the purpose of reducing jobsite waste by taking back their uninstalled waste flooring. Details of the Nora program are available on www.nora.com/us.

2.2 RESILIENT TILE FLOORING FOR COMMERCIAL TRAFFIC

- A. Product Name: Noraplan® sentica,
 - 1. Material: Nora vulcanized rubber compound 913 with abundant natural fillers and environmentally compatible color pigments
 - 2. Surface: Smooth
 - 3. Color: As selected from manufacturer's standard palette of colors. Up to three different colors may be selected per finish schedule.
 - 4. Tile Size: 0.12 inches (3mm) thickness, 24 inches by 24 inches (610mm by 610mm)
 - 5. Back of Tile: Smooth, double-sanded back.
 - 6. Composition: Homogeneous rubber compound 913 with a random scattered design
 - 7. Limited Wear Warranty: 5 years
 - 8. Hardness: ASTM D2240, Shore type A, required ≥ 85
 - 9. Static Load: Per ASTM F970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs. ≤ 0.005 "
 - 10. Quality of Cut: ASTM F511 ≤ 0.005 "
 - 11. Squareness: ASTM F2055 ≤ 0.010 "
 - 12. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
 - 13. PVC Free: Product shall contain no polyvinyl chloride
 - 14. Abrasion Resistance: Taber abrasion test, ASTM D3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss ≤ 0.4
 - 15. Slip Resistance: Static coefficient of friction (James Test): ASTM D2047, ≥ 0.8
 - 16. Bacteria Resistance: Product shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E2180 and ASTM G21
 - 17. Halogen Free: Product shall contain no halogens
 - 18. Sound Absorption: 10 dB per ISO 140-8 and 42 IIC per ASTM E2179
 - 19. Burn Resistance: Cigarette and solder burn resistance
 - 20. Heat Resistance: Avg. Delta E < 8.0 per ASTM F1514
 - 21. Flammability: ASTM E648; NFPA 253; NBSIR 75 950, ≥ 0.45 watts per square centimeter, Class 1
 - 22. Smoke Density: ASTM E662, NFPA 258, NBS smoke density, < 450
 - 23. Asbestos Free: Product shall contain no asbestos
 - 24. Static Generation: < 2000 Volts (2KV) at 20% RH as per AATCC 134

25. Non Hazardous: Flooring shall be made without any chemicals that may be hazardous or containing any teratogenic, mutagenic or any other ingredients known to be carcinogenic
26. Cleaning: Flooring surface shall have the ability to be cleaned and maintained without the use of any chemicals that may be hazardous or containing any teratogenic, mutagenic or any other ingredients known to be carcinogenic. Manufacturer shall make available a cleaning system that effectively cleans the flooring surface using water, cleaning pads and a suitable cleaning machine, without the use of factory and/or field-applied coatings.
27. Shine: Higher shine surfaces can be achieved by dry buffing without any artificial topical applied coatings
28. Installation System: Use only Nora® pro install system products following the current Nora Installation Guide that may consist of part or all of the following steps depending upon the substrate conditions and requirements of the specific project.
 - a. Step 1 – Nora® membrane (see Installation Guide for requirements).
 - b. Step 2 – Nora® primer (see Installation Guide for requirements).
 - c. Step 3 – Nora® leveler (see Installation Guide for requirements).
 - d. Step 4 – Nora® patch (see Installation Guide for requirements).
 - e. Step 5 – Nora® adhesives, the flooring usage and substrate conditions will determine the appropriate adhesive. Contact your Nora representative for specific recommendations.

PART 3 EXECUTION

3.1 PREPARATION

- A. Provide a building or flooring area that is water tight and fully enclosed from the elements, including roof, windows or facades and doors, that is ready for the flooring installation is required.
- B. A concrete substrate that fully conforms to the requirements of ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring is required, or as detailed in the Nora Installation Guide.
- C. A concrete substrate that shall be structurally sound, that is finished shrinking, cracking, curling or moving in any way is required.
- D. For all concrete substrates on or below grade, a permanent effective vapor retarder with a low permeance (less than 0.1) having a minimum thickness of 10 mils, or meets the requirements of the latest edition of ASTM E1745 (Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs) shall be placed directly underneath the concrete above the granular fill, and shall be installed as per the manufacturer's written instructions. A letter shall be provided to the end user confirming the correct products have been used and that it is fully warranted, alternatively the Nora membrane shall be used as described in 3.01 H.

- E. A clean non-burnished concrete surface free from any paint, wax, oil, grease, and film forming curing compounds, silicate penetrating curing compounds, sealing, hardening or parting compounds is required. The surface should not have any alkaline salts, laitance, mold, mildew, residual adhesive, chemical adhesive removers or anything that may prevent the appropriate pro install products bonding to it. If not then the general contractor should provide the mechanical means to remove them. This could be dustless diamond grinding, bead-blast or similar with a suitable vacuum attachment.
- F. Valid tests and acceptable test results shall be provided to the end user and flooring contractor, including documenting with photographs, the location of all tests, recorded moisture content and temperature of the concrete subfloor prior to flooring installation. Testing shall be confirmed to have been performed at the correct, controlled ambient service temperature and humidity following the protocol of ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes, using a Wagner Rapid RH probes only. When tested at the correct service temperature and ambient humidity the maximum allowable shall be 85%RH for the correct Nora® 385, 485, 585 or 685 adhesive or 75%RH for Nora® dryfix, stepfix or Quickfix systems.
- G. If it is not possible to drill into the concrete for any reason as detailed in ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes, please contact the Nora Technical Department for other recommendations.
- H. A secure storage area that is maintained permanently or temporarily at ambient service temperature and humidity (except walk in freezers or similar), or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and $50\% \pm 10\%$ relative humidity, for at least 48 hours prior to and during the application of the flooring, so the flooring contractor can acclimate the flooring materials is required.
- I. An installation area that is weather tight and maintained permanently or temporarily at ambient service temperature and humidity (except walk in freezers or similar), or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and $50\% \pm 10\%$ relative humidity, for at least 48 hours prior to, during and 72 hours after the application of the flooring is required.
- J. Areas of the flooring that are subject to direct sunlight through doors or windows shall have them covered using blinds, curtains, cardboard or similar for the time of the installation and 72 hours after the installation to allow the adhesive to cure. Note these areas shall be installed using wet adhesives only.
- K. Prevent all traffic for a minimum of 12 hours and heavy rolling loads for 72 hours to allow the adhesive to set up. If required, after 12 hours protect the flooring from damage during construction operations using Masonite, plywood or a similar product, ensuring first that the flooring surface is free of all debris. Lay panels so that the edges form a butt joint and tape the joint to prevent both movement and debris entrapment underneath them. Inspect immediately before covering and after removal for final acceptance.
- L. If required, clean the flooring no sooner than 72 hours after the installation, unless pre-agreed with a Nora representative. Clean the flooring only using the method detailed in the appropriate Nora Maintenance Guide.

3.2 INSTALLATION

- A. Installer shall be trained and have at least one of the following:
 - 1. Approved by Nora systems, Inc. for all of the requirements of the project.
 - 2. INSTALL (International Standards & Training Alliance) certified for the requirements of the project.
- B. An effective project manager, to manage the installers, and ensure that all of the required procedures are followed, documented and that the Nora Installation Guide is followed.
- C. Acclimate the flooring in the secure storage area provided by the general contractor that is maintained permanently or temporarily at ambient service temperature and humidity (except walk in freezers or similar), or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and 50% relative humidity, for at least 48 hours prior to application.
- D. Perform mat bond tests in each major area (1 per ~1,000 sq. ft.) This shall consist of the proposed subfloor preparation, mitigation and leveling or smoothing products. A detailed method statement is available in the Nora Installation Guide available on www.nora.com/us. Do not proceed with the installation until all the results of the bond test are acceptable.
- E. Clean out and fill or repair any dormant saw cuts and cracks following the appropriate directions of the membrane, leveler or patch sections within the installation guide. For any expansion (moving) joints, use an industry standard expansion joint assembly.
- F. When required, use the Nora membrane following the directions and requirements detailed within the Nora Installation Guide. Provide written confirmation and photographs to the general contractor or end user that the subfloor was prepared correctly prior to the application of the membrane, and that the membrane was applied correctly (without pin-holes) including confirmation of the gallons used and total square feet installed.
- G. If required, use Nora leveler following the Installation Guide. They shall be free of dust, solvents, paint, wax, varnish, oil, grease, asphalt, old adhesives, and other extraneous materials that may interfere with the bond. These shall be completely removed by mechanical means only. Dustless diamond grinding is the preferred method to remove contaminates and bond breakers as it also helps to level the concrete.
- H. Prime the subfloor prior to using the leveler. Note: a 1/8th inch minimum thickness is required for the leveler to be considered porous as required when using Nora 485 or 685 acrylic adhesives.
- I. If Nora leveler or patch is used, provide written confirmation and a workmanship warranty that (if required) the area was primed correctly, the leveler had been mixed and applied correctly to the required smoothness and or thickness of the general contractor / end user, or Nora Installation Guide.

- J. Vacuum floors immediately prior to installing the flooring to remove all loose particles. If required, only use water based sweeping compounds. Do not use any wax or oil based compounds that leave behind a residue that may interfere with the adhesive bond.
- K. Install resilient flooring, including but not limited to the following, in accordance with the Nora Installation Guide.
 - 1. Do not mix manufacturing batches of a color within the same area.
 - 2. Do not install resilient flooring over building expansion joints.
 - 3. Do not install defective or damaged resilient flooring.
 - 4. Layout resilient flooring to provide ~equal size at perimeter. Adjust layout as necessary to reduce the amount of resilient flooring which is cut to less than half full width.
 - 5. Lay resilient flooring with arrows in the same direction (excluding borders).
 - 6. Install resilient flooring without voids at seams. Lay seams together without stress.
 - 7. Cut/scribe resilient flooring neatly at perimeter and obstructions.
 - 8. Extend resilient flooring into reveals, closets, and similar openings.
 - 9. Remove excess adhesive immediately.
 - 10. Install reducer strips at exposed edges.
- L. Install Nora wall base in accordance with manufacturer's installation guide. Install in longest practical lengths.
- M. Touch-up and repair any minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired.

3.3 MANUFACTURER RESPONSIBILITIES

- A. Provide a one-year warranty against defects in manufacturing of all products supplied. Provide limited wear warranty for the flooring supplied, as detailed per product. Provide a Nora Pro Install System warranty upon receipt of the required test results and documentation. Contact the Nora Technical Department for details.
- B. Adherence to the Quality Management System approved by Lloyd's Register Quality Assurance to the Quality Management System Standard ISO 9001:2000.
- C. Provide flooring that shall contain no polyvinyl chloride or plasticizers.
- D. ISO 14001 Environmental Management Systems certification.
- E. Provide training for the installers at a Nora Technical Academy; contact the Nora Technical Department for details and availability.
- F. Provide an effective surface moisture mitigation membrane that has three (3) levels of protection (depending on %RH moisture content of the concrete), and that is in compliance (46 grams/liter) with SCAQMD Rule 1113, <100 grams/liter.

- G. Provide a water based primer, that is suitable for both porous and non-porous substrates including Nora membrane, and that is in compliance (92 grams/liter) with SCAQMD Rule 1113, <100 grams/liter.
- H. Provide a self-smoothing Portland cement based leveler, that can pumped or barrel mixed with water and be used at a minimum of 1/8th inch that is in compliance (0 grams/liter) with SCAQMD Rule 1168, <50 grams/liter.
- I. Provide a Portland cement based patching compound that can be used from a feather edge to 1 inch in one application and is in compliance (0 grams/liter) with SCAQMD Rule 1168, <50 grams/liter.
- J. Provide flooring that shall contain no halogens.
- K. Provide flooring surfaces that shall be easily cleaned and not require coatings and stripping, or use chemicals that may be hazardous to human health.
- L. Provide flooring that shall be free of anything known to be teratogenic, mutagenic or carcinogenic.
- M. Provide adhesives that are in compliance (0 grams/liter) with SCAQMD Rule 1168, <60 grams/liter Standard for Rubber Floor Adhesives.

END OF SECTION

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SECTION 09 68 13

TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section specifies carpet, accessories, and installation.

1.2 SUBMITTALS

- A. Shop Drawings showing layout and seaming diagrams. Indicate pile or pattern direction, locations and types of edge strips. Indicate columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet. Show installation details at unusual conditions.
- B. Product Data for each type of carpet materials and installation accessory required. Submit written data on physical characteristics, durability, resistance to fading, and flame resistance characteristics.
- C. Samples for verification purposes showing full range of color, texture, and pattern variations expected. Use materials proposed for inclusion in Work. Submit the following Samples:
 - 1. Carpet Materials: 12 inches square.
 - 2. Each Type Exposed Edge Stripping and Accessory: 12 inches long.
 - 3. Each Type of Carpet Cushion: 6 inches square.

1.3 QUALITY ASSURANCE

- A. Carpet Surface Burning Characteristics: Provide carpet identical to that tested for the following fire performance characteristics, in accordance with test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify carpet with appropriate markings of applicable testing and inspecting organization.
 - 1. Test Method: DOC FF 1-70.
 - 2. Rating: Pass.
- B. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- C. Mockups: Before installing carpet tile, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

1.4 DELIVERY AND STORAGE

- A. Deliver materials to Project site in original factory wrappings and containers, labeled with identification of manufacturer, brand name, and lot number.
- B. Store materials in original undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soilage, extreme temperatures, and humidity. Lay flat, blocked off floor. Maintain minimum temperature of 68°F at least 3 days prior to and during installation in area where materials are stored.

1.5 PROJECT SUBSTRATE CONDITIONS

- A. No condensation within 48 hours on underside of 4' x 4' polyethylene sheet, fully taped at perimeter to substrate.
- B. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- C. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- D. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer – typically pH of 9 or less when substrate wetted with potable water and pHydration paper applied.
- E. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.6 SPARE PRODUCTS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Store spare products at location directed.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

PART 2 PRODUCTS

2.1 CARPET (OWNER SHALL MAKE FINAL SELECTION OF COLOR AND PATTERN)

- A. Carpet specified below is "Spring Break #8358 Campsite, Mohawk". Carpet by Karastan-Bigelow, Mohawk Carpet meeting the following construction requirements:
 - 1. Description: Tufted textured loop pile.
 - 2. Fiber Content: 100% DuPont solution dyed BCF Nylon with Duratech Soil Protection.
 - 3. Tufted Yarn Weight: 26.0 oz./sq.yd. (min.)

4. Tufted Pile Height: .187 inches
5. Finish Pile Thickness: .106 inches (min.)
6. Gauge: 1/10 (min.)
7. Stitches per Inch: 6.3 (min.)
8. Total Weight: 61.0 oz./sq.yd.
9. Density: 6810 oz./sq.yd. (min.)
10. Weight Density: 190,680 (min.)
11. Stock Colors: Solution dyed/Space dyed.
12. Flammability:
 - a. Pill Test (Doc FF1-70): Pass.
 - b. Radiant Panel (Direct Glue): ASTM E 648: Class I.
 - c. NBS Smoke Density: ASTM E 662.
 - 1) Flaming Mode: <450 at 4 minutes <450.
 - 2) Non-flaming Mode: <450 at 4 minutes <300.
13. Static:
 - a. AATCC-134: <3.5 kV.
 - b. Type Static Control: Permanent Conductive Fiber.

2.2 GENERAL

- A. Materials shall be uniform in color and texture.
- B. Carpeting within each area shall be from one production run as indicated by cartons bearing same manufacturer's color code.
- C. Colors:
 1. The specified carpet type and color shall be approved by the Owner prior to purchase.
 2. Carpet color will be selected from stock colors. Approximately 15% of carpet selected will be a solid accent coordinating color to be installed in a pattern to be defined by the Architect.

2.3 ACCESSORIES

- A. Tackless Carpet Stripping: Water-resistant plywood strips of thickness required to match cushion thickness. Three rows rust resistant angular pins; length to penetrate carpet backing, but not be visible from surface or to be a safety hazard.
- B. Concrete Nails: Concrete stub nails, case-hardened.
- C. Carpet Edge Guard: Hammered texture aluminum with fold-down edge and concealed gripper teeth; minimum 1-1/2 inch wide punched anchorage flange; minimum 5/8-inch wide fold flange. Anodized aluminum finish, manufacturer's standard colors.
- D. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

- E. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove debris and cementitious deposits from concrete surfaces to receive carpet. Sweep and vacuum substrate. Apply sealer to prevent dusting.
- B. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- C. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- D. Delete first paragraph below if products are not adhesively applied to concrete substrates. Revise to suit Project.
- E. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- F. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

3.2 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Revise first paragraph below if mill-applied peel-and-stick adhesives or standard adhesives are used. Revise second option if spot-glued installation is recommended by manufacturer.
- C. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
 - 1. For raised access flooring provide factory installed carpet tile on raised access panels.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Install pattern parallel to walls and borders.

3.3 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge and delamination.
 - 1. Verify available warranties and insert number in subparagraph below.
 - a. Warranty Period: 10 years from date of Substantial Completion.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure carpet is not damaged or deteriorated at time of Project completion.

END OF SECTION

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SECTION 09 91 26

PAINTING BUILDING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Section Includes: Paints, coatings, primers, sealers, varnishes, stains, and other related materials necessary for application of painting systems shown on Drawings, Finish Schedules, and specified.
- B. This Section also includes preparation of surfaces to receive specified painting systems and application of paint and finish materials.

1.2 WORK EXCLUDED

- A. Following items and surfaces are excluded from Work covered under this Section:
 - 1. Exterior, exposed poured-in-place, and precast concrete, except as noted otherwise.
 - 2. Non-ferrous metals, except as noted otherwise.
 - 3. Walls and ceilings in areas scheduled as unpainted.
 - 4. Prefinished wood, plastic laminate, acoustical tile, wall covering, and paneling.
 - 5. Resilient, ceramic, and quarry tile.
 - 6. Prefinished metal surfaces.
 - 7. Concrete floors, unless otherwise scheduled.
 - 8. Touch-up of structural steel prime coat.
 - 9. Concealed electrical conduits and fittings.
 - 10. Underground piping and fittings.
 - 11. Yard storage tanks and vessels, except as specifically listed.
 - 12. Warning: Do not paint moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, contacts, linkages, sensing devices, motor and fan shafts, and fire sprinkler heads. Provide covering and tape in place during spray painting operations unless otherwise indicated.
 - 13. Do not paint over code-required labels such as Underwriters' Laboratories, Inc. and Factory Mutual, or equipment identification, performance rating, name, or nomenclature plates.
- B. Work by Others:
 - 1. Patching, pointing, filling, and cleaning of masonry surfaces.
 - 2. Caulking for masonry work.
 - 3. Patching, pointing, filling, and cleaning of concrete surfaces.
 - 4. Patching and filling defects in drywall.

1.3 QUALITY ASSURANCE

- A. Painting Schedule in this Section is intended to list various types of coating systems to be applied to specific materials. Coating Contractor to be responsible for using applicable coating systems as listed, conforming to coatings or finishes shown on Finish Schedule on Drawings.
- B. Proper surface preparation, manner and technique of application, adherence to manufacturer's stated spreading rate, and number of coats applied to be Painting Contractor's responsibility. Compliance with these spreading rates will be checked on Project with a dry mil thickness gauge.
- C. Field Sample Panels: Prior to beginning painting application, prepare and obtain approval of sample panel of each color to be used.
 - 1. Apply sample coatings on representative areas of actual job surfaces and locate as directed. Leave sample panels in place until painting work is completed and accepted. Refinish sample panels after painting work is accepted.
 - 2. Sample Panel Size: Minimum of 4 feet square.
 - 3. Panels will be checked for texture, color, mil thickness, and conformity with this Section.
 - 4. Approved field samples to serve as minimum acceptable standards for finished painting work.
- D. Qualifications of Applicator: Authorized representative of the materials manufacturer.
- E. Field Inspections: Representative of materials manufacturer to be on jobsite before and during portion of application for consultation and to inspect surfaces to which materials are being applied and manner in which materials are being applied.
- F. Finish Schedules: Color and Finish Schedules will be furnished to Contractor before start of painting Work. Color and Finish Schedules will indicate colors selected and locations and type surfaces where painting materials are to be applied. Each room will include one accent wall color.
- G. Provide every facility for inspection of Work, whenever required.

1.4 SUBMITTALS

- A. Color Chips:
 - 1. Reviewed before materials are ordered.
 - 2. Submit 2 color chips of each color, representative of finish of actual colors to be used.
- B. Materials Proposed: Submit for review before award of Contract, list showing manufacturer's name, brand name, and types of painting materials proposed, type of surface to receive each coating and showing quantities per square foot which will be used

on complete project. Quantity of materials used on this Project not to be less than as specified or as recommended by materials manufacturer and approved.

1. Review of submittals does not relieve Contractor of responsibility to fulfill requirements of the Specifications and Drawings, unless Contractor enumerates deviations and obtains written approval to use those deviations.
 2. No substitution of material will be permitted, except by written authority.
- C. Manufacturer's Specifications: Furnish Painting Contractor painting specifications with detailed instructions for application of types of painting materials to be used.
1. Manufacturer's specifications to be furnished after materials proposed have been reviewed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
1. Deliver painting materials to Project site in manufacturer's original labeled and sealed containers bearing manufacturer's name, brand designations, and printed application instructions.
 2. Maintain seals unbroken until after inspection and acceptance of materials.
 3. Do not deliver materials until color chips are reviewed.
- B. Storage and Handling:
1. Provide suitable storage for exclusive use of paint storage and paint mixing. No space will be allowed in building for these purposes.
 2. Store materials in suitable dry and ventilated area and protect from damage, deterioration, and contamination.
 3. Store materials in manufacturer's original unopened containers until ready for use at minimum ambient temperature of 45°F.
 4. Comply with regulations for storage, mixing, and use of paint. Post necessary safety signs required by local and state codes and in conformity with good practice.

1.6 ENVIRONMENTAL CONDITIONS

- A. Apply no paint immediately after rain, during rainy weather, or when temperature is below 50°F.
- B. Painting will not be permitted while dust, lint, or harmful number of insects are in air.
- C. Temperature of substrate must be 5°F minimum above dew point and within minimum and maximum ambient temperature recommended by manufacturer.
- D. Apply paint materials under conditions favorable to drying, with no moisture present, no moisture expected during following 48 hours and relative humidity is less than 85%.
- E. Apply paint materials to dry and cured surfaces.

- F. Provide adequate ventilation in areas in which paint materials are being applied.
- G. Begin no interior painting until building is roofed in.

1.7 SCHEDULING

- A. Deliver materials in ample quantities sufficiently in advance of need to avoid delays or interruptions in Work due to lack of proper materials.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Referenced manufacturer, unless otherwise specified, is Sherwin Williams Company.
- B. Provide paint materials from one source unless otherwise approved.

2.2 PAINTING MATERIALS

- A. As specified in Painting Schedule, Paragraph 3.10.
 - 1. Provide paints well ground and easily mixed with no hard settling or caking in containers.
 - 2. Paints to be readily broken up with paddle to smooth uniform paint of good brushing consistency and to dry hard to smooth finish without streaking, running, or sagging.
 - 3. Shop-applied and field-applied primers and finish coats must comply with appropriate local, state and federal emission standards for Volatile Organic Compounds (VOC).
 - 4. Coatings (primers and finish coats) must be free of lead and chromate hazards.
 - 5. Provide primers, sealers, and undercoatings for paint work of same manufacturer as brand of the paint used in this Section, unless specified otherwise.
 - 6. Colors: As shown on Finish Schedule and matching approved color chips and field sample panels.
 - 7. Color or finish of various surfaces may be varied to obtain desired effect without increasing cost.

PART 3 EXECUTION

3.1 INSPECTION

- A. Before starting painting or finish in a room, space, or area, thoroughly examine underlying and adjoining work and conditions. Report in writing condition which might adversely affect Work. Do not apply paint materials until defective conditions are corrected.
 - 1. No "Waiver of Responsibility" for incomplete, inadequate, or defective underlying or adjoining work will be considered unless notice of unsatisfactory

conditions has been filed and agreed to, in writing, before beginning work in question.

2. Application of first field coat will be construed as evidence that painting Contractor accepts such underlying surfaces as being in proper condition for application of this Work.

- B. Where there is question of dryness of surfaces, test surfaces in presence of Owner's field representative. Apply no paint to masonry or concrete surfaces when moisture content exceeds 8% as determined by reliable electronic moisture meter.

3.2 SAFETY PRECAUTIONS AND CONTRACTOR'S EQUIPMENT

- A. Safety: Perform painting under conditions and in a manner dictated by safe practice, using materials, tools, and rigging of safe character.
 1. Comply with recognized safety rules and practices necessary to permit safe working conditions for workmen and prevent hazards to others who may be in vicinity of Work.
 2. Do no painting on or in vicinity of energized electrical lines or rotating equipment apparatus without approval and then only in accordance with applicable laws, rules, ordinances, or regulations.
- B. Ladders, Scaffolding, and Staging: Furnish, erect, maintain, and promptly remove, upon completion of the painting and finishing, necessary ladders, scaffolding, and staging required for the Work under this Section, arranged to cause least possible interference with work of other trades.
 1. Be responsible for damage caused by erection or removal of above mentioned equipment.
 2. Should it become necessary to remove scaffolding, staging, ladders, or other similar equipment to permit installation of work of other trades, move these items as required without additional expense. Coordinate work to avoid conflict with other trades.
- C. Combustible Materials:
 1. Store paint, varnish, enamel, oil, turpentine, and other combustible or flammable materials within building in receptacles with tightly closed covers each night or after each work period. Limit storage of paint materials in the building to quantity used in 1 day's work.
 2. Remove oil or paint saturated cloths, rags, or waste from building after each day's work.
 3. Refer to Paragraph 1.5 for paint material storage.

3.3 SURFACE PREPARATION

- A. Sand interior work and trim smooth with the grain, and never across it. Correct surface blemishes and clean room and wood surface of dust before proceeding with finishing coats. After priming coat has been applied, fill nail holes, breaks and crevices with putty.
- B. Scrape knots and pitch streaks, then coat with shellac before priming coat is applied. Fill nail holes or small openings with putty.

- C. Wire-brush masonry surfaces and remove loose materials and extraneous matter. Use solvents to remove grease and oil. Exercise care to prevent application of paint to surfaces where free lime has not been neutralized. Where necessary, surfaces may be washed down with solution composed of 3 pounds of zinc sulphate per gallon of water. Brush off crystalline residue after surface has thoroughly dried.
- D. Prepare metal surfaces for final painting in accordance with paint manufacturer's recommendations and specifications.
 - 1. Clean painted cast metal surfaces of detrimental foreign matter such as oil, grease, soil, and cutting compounds by use of solvents.
 - 2. Clean unpainted cast metal surfaces by wire-brushing. Repair surface defects with iron filler.
 - 3. Clean unprimed steel, such as miscellaneous rolled shapes, bulk purchased floor plate, and field-fabricated shapes for painting by wire-brushing. Inspect shop-primed metal surfaces, except as noted below, to determine adhesion of primer to steel before cleaning. If bond is poor, clean surface thoroughly. Where bond is satisfactory, clean surface by wire-brushing or by solvent cleaning.
 - 4. Treat galvanized metal surfaces that are to be painted as specified in Painting Schedule, under Galvanized Metals.
- E. Concrete Preparation:
 - 1. Wire brush concrete surface to remove loose material and extraneous matter. Remove grease, oil, dirt, or other foreign matter by solvent or detergent washing.
 - 2. Remove dust from surfaces before painting.
 - 3. Acid Etching, Where Specifically Required for Concrete Surface Preparation:
 - a. Surfaces to be clean and dry, free from curing compounds, oil, grease, dirt, chalk, or previously applied coatings.
 - b. Etch surfaces with muriatic acid solution. Strength of acid solution to be in accordance with specific requirements for surface preparation under individual coating system. Apply solution with brush or spray until surface is thoroughly wetted.
 - c. When bubbling ceases (about 5 to 10 minutes), wash down surfaces with fresh water and scrub with stiff brush. Rinse with plenty of water.
 - d. If surface is acidic (pH below 7), neutralize by washing with 1% to 2% ammonia solution.
 - e. Allow surface to dry below 8% moisture content before applying coating.
- F. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely before paint material application.

3.4 MIXING AND THINNING PAINT MATERIALS

- A. Mixing: Mix paint materials only at Project site, with exception of factory-mixed materials. Provide new non-rusting containers of suitable size for mixing of painting materials at Project. Mixing will not be permitted outside of these containers.
 - 1. Thoroughly mix and stir paint materials, both before and during use, to obtain uniformity of color and finish.

- B. Thinning of Paint Materials, if Required: Conform to manufacturer's directions, using only thinning agents in quantities recommended. Adulteration will not be permitted. If excess thinning is done, and finished Work, using number of coats specified, is not satisfactory, apply additional coats, as required, to meet approval without additional cost.

3.5 PAINTING APPLICATION

- A. General: Apply paint materials in accordance with paint materials manufacturer's specifications and this Section.
 - 1. Do not exceed spread per gallon specified or recommended by paint manufacturer.
 - 2. Film thicknesses, where indicated, are expressed in dry film thickness (DFT).
- B. Apply painting finishes of the grade, executed by skilled, experienced workmen. Careless or incompetent persons will not be allowed on job.
- C. Apply painting materials by spray, roller, or brush in accordance with manufacturer's recommendation for type surfaces to receive painting materials.
- D. Maintain brushes, rollers, and spray equipment clean and in proper condition.
- E. Apply materials to completely cover surfaces evenly and to dry uniformly to color and sheen specified, free from runs, sags, wrinkles, shiners, streaks, and brush marks. Apply each coat smooth, worked out evenly and allow to dry before subsequent coat is applied.
- F. Do not float on paint, that is, do not apply thick heavy coats.
- G. Thoroughly brush priming coat into pores and crevices.
- H. Make edges of paint adjoining other materials or colors sharp and clean without overlapping.
- I. Between succeeding coats, notify Owner's field representative before proceeding with Work so that it may be inspected, if necessary, and credited as applied coat. Failure to do so may result in recoating at painting Contractor's expense.
- J. Before applying each coat, make certain previous coat is ready to receive next specified coat. Previous coating to be thoroughly cured. Allow suggested drying time and check film with fingernail to be certain it is cured. Remove noncompatible and non-adherent materials from previous coat. Surface and ambient temperature to be within minimum and maximum recommended by manufacturer. Stop exterior work sufficiently early to permit film to set up before condensation, frost, and moisture caused by night temperature drop occurs.
- K. Sand enamel and varnish undercoats smooth prior to recoating.
- L. Paint top and bottom of doors. Paint cutouts for hardware.

- M. Paint or finish surfaces left purposely unfinished to meet requirements of other trades as part of Work under this Section only after previous work requiring unfinished surfaces is completed and approved.
- N. Apply painting systems in number of coats at rate and for minimum dry film thickness specified under Painting Schedule.
- O. Where prime coats are not compatible with special coatings or finish paint coats, apply proper barrier coating prior to application of special coatings or finish paint coats, as recommended by materials manufacturer. Example of this condition occurs when any epoxy paint is to be applied over alkyd primer. Alkyd paint is not compatible with strong solvents in epoxy paint. Also, sprayed fireproofing is sometimes not compatible with prime coats.

3.6 PROTECTION DURING APPLICATION

- A. Take necessary precautions for protection from paint spattering and droppings on installed plumbing fixtures, hardware, electrical switchgear, transformers, bus ducts, panelboards, factory painted equipment, lighting fixtures, fittings, glass, doors, equipment, instruments, and similar items to extent of removing and replacing those parts as are necessary.
- B. Furnish, hang or spread, and maintain necessary drop cloths, tarpaulins, and other means of protecting Work and work of other trades, either installed or in process of installation. Remove such protection at completion of work. Be responsible for damage resulting from Work under this Section and arrange with interested trades to restore such damaged work to its original condition at his own expense.
- C. Hang tarpaulins over openings to spaces being painting or finished, where spaces are not otherwise enclosed and which are subject to excessive dust conditions due to adjacent operations or other trades. Where it becomes necessary to remove coverings placed by other trades, replace them in original position after work which required removal has been executed.

3.7 CLEAN-UP AND REPAIR

- A. Clean-Up: During construction and up to completion of building, clean-up and remove from premises, as may be necessary or as directed, surplus materials, tools, appliances, empty cans, cartons, and rubbish resulting from Work of painting and finishing. Leave rooms and spaces clean. Remove paint and oil spattering, drippings, and stains resulting from painting work from painted surfaces and from work of other trades.
- B. Repair: Repair paint work which has become damaged or defaced during course of construction and completion of Project and leave painting and finishing in clean, neat, and perfect condition, as acceptable. Replace broken glass and damaged material directly attributed to painting work under this Section.

3.8 PROTECTION OF COMPLETED WORK

- A. Protect coated surfaces until the Project has been accepted.

3.9 MAINTENANCE PAINTING SCHEDULE

- A. Furnish after completion of painting work Maintenance Painting Schedule for use in maintenance painting, indicating description (type, color, mil thickness, etc.) of each type paint material used and location where used.

3.10 PAINTING SCHEDULE

- A. Surfaces to be painted, painting systems, and number of coats to be applied to be in accordance with Painting Schedule as outlined below and manufacturer's printed instructions. Spread rates indicated are theoretical.
- B. Structural Steel Shop Primer:
 - 1. Structural steel shop primer as specified in Section 05 12 00 of Specifications. If primer other than Sherwin-Williams B50 N Z6 (Brown) or Sherwin-Williams B50 W Z1 (White) are used, assume responsibility for compatibility of following systems to be used over those primers.
 - 2. Use white or brown color touch-up primer to match original primer color.
- C. Exterior Coating Systems:
 - 1. Exposed Structural Steel and Miscellaneous Metals, Steel Channel Door, and Wall Opening Frames:
 - a. Touch-up or 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 3.0 mils DFT (VOC 3.45 pounds/gallon).
 - b. 2 coats S-W Industrial Urethane Alkyd Enamel (VOC Complying), 377 sq. ft/gal, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).
 - 2. Handrails, Stairs, Ladders, Cages, and Pipe Guards:
 - a. Touch-up or 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 3.0 mils DFT (VOC 3.45 pounds/gallon).
 - b. 2 coats S-W Industrial Enamel (VOC Complying) B54Z Series, 377 square feet/gallon, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).
 - 3. Exposed Galvanized Steel and Galvanized Flashings:
 - a. Solvent clean per SSPC SP1.
 - b. 2 coats S-W DTM Acrylic Gloss Coating, B66 Series, spread rate 209 square feet/gallon, 3.0 mils DFT per coat (VOC 1.92 pounds/gallon).
 - 4. Roof Hatches, and Smoke Vents:
 - a. Touch-Up or 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 2.5 mils DFT (VOC 3.45 pounds/gallon).
 - b. 2 coats S-W Industrial Enamel (VOC Complying), B54Z Series, spread rate 377 square feet/gallon, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).

5. Hollow Metal Doors and Frames:
 - a. Touch-Up or 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 2.5 mils DFT (VOC 3.45 pounds/gallon).
 - b. 2 coats S-W Industrial Enamel (VOC Complying) B54Z Series, spread rate 377 square feet/gallon, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).
 6. Fire Hydrants and PIVs:
 - a. 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 2.5 mils DFT (VOC 3.45 pounds/gallon).
 - b. 2 coats S-W Industrial Enamel (VOC Complying) B54Z Series, 377 square feet/gallon, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).
 7. Exposed Piping (Uninsulated):
 - a. Carbon Steel:
 - 1) 1 coat S-W Kem Kromik Universal Primer Brown, B50 N Z6, spread rate 327 square feet/gallon, 2.5 mils DFT (VOC 3.45 pounds/gallon).
 - 2) 2 coats S-W Industrial Enamel (VOC Complying), B54Z Series, 377 square feet/gallon, 2.0 mils DFT per coat (VOC 3.48 pounds/gallon).
- D. Interior Coating Systems:
1. Exposed Structural Steel Columns, Girts and Miscellaneous Metals:
 - a. Semi-Gloss Finish:
 - 1) Touch-up S-W Kem Kromik Universal Brown, B50 N Z6 (VOC 3.45 pounds/gallon).
 - 2) 2 coats S-W ProMar 200 Alkyd Semi-Gloss B34 W Z1100 Series, spread rate 400 square feet/gallon, 2.0 mils DFT per coat (VOC 3.10 pounds/gallon).
 2. Exposed Galvanized Steel (Other than Roof Deck):
 - a. Semi-Gloss Finish: Solvent clean per SSPC SP1.
 - 1) 1 coat S-W DTM Acrylic Primer/Finish B66 W1, spread rate 247 square feet/gallon, 3.0 mils DFT (VOC 1.15 pounds/gallon).
 - 2) 2 coats S-W ProMar Alkyd 200 Semi-Gloss B34 W Z1100 Series, spread rate 400 square feet/gallon, 2.0 mils DFT per coat (VOC 3.1 pounds/gallon).
 3. Gypsum Drywall – where noted in Room Finish Schedule as “PAINTED”:
 - a. Semi-Gloss Finish:
 - 1) 1 coat S-W ProMar 200 Latex Primer B28 W200, spread rate 400 square feet/gallon, 1.5 mils DFT per coat (VOC 0.11 pounds/gallon).
 - 2) 2 coats S-W ProMar 200 Latex Semi-Gloss B31 W200, spread rate 400 square feet/gallon, 1.5 mils DFT per coat (VOC 1.63 pounds/gallon).
 4. Gypsum Drywall – where noted in Room Finish Schedule as “EPOXY PAINT”:
 - a. Low Luster Finish:
 - 1) Pro Industrial HB WB Hi-Bild Water Based Catalyzed Epoxy

5. Hollow Metal Doors and Pressed Metal Frames:
 - a. Semi-Gloss Finish:
 - 1) Touch-up or 1 coat S-W Kem Kromik Universal Primer Brown B50 N Z6, spread rate 327 square feet/gallon, 3.0 mils DFT per coat (VOC 3.45 pounds/gallon).
 - 2) 2 coats S-W ProMar 200 Alkyd Semi-Gloss B34 W Z1100, spread rate 400 square feet/gallon 1.4 mils DFT per coat (VOC 3.1 pounds/gallon).
6. Wood Doors and Frames, Finish Carpentry and Trim:
 - a. Stained Finish or Natural finish as specified by Owner:
 - 1) 1 coat S-W Oil Stain A48 Series (omit if natural finish is desired)
 - 2) 1 coat S-W ProMar Sanding Sealer B26 V3, spread rate 400 square feet/gallon, 0.5-1.0 mils DFT
 - 3) 2 coats S-W Oil Based Varnish A66 V92, 400 square feet/gallon, 1.0 mils DFT per coat.

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SECTION 10 14 00

SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes furnishing and installing exterior and interior signs.

1.2 SUBMITTALS

- A. Samples: Sign Vendor shall provide samples of each sign component for selection of color, pattern, surface texture, and thickness, as required for verification of compliance with Project requirements.
- B. Architect shall select sign configuration, including material, colors, and fastener requirements if not addressed in this specification.

1.3 QUALITY ASSURANCE

- A. Sign Fabricator Qualifications: Manufacturer with minimum three years experience specializing in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.
- B. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Interior and Exterior Signs: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Manufacturers:
 - 2. APCO Graphics.
 - 3. ASI Sign Systems.
 - 4. Inpro Architectural Products
- B. Exterior Signage: Messenger Exterior Monolith modular flat faced architectural signage system

1. Panel size 4' by 6', colors and letters from manufacturers standards.
 2. Graphics to include City of Arlington flying "A" logo, City of Arlington, Laboratory and Maintenance Facility and address.
 3. Messenger exterior wall mount signs, provide 2 panels, size 18" by 24", mounted adjacent to main entry (MAINTENANCE TRAINING LABORATORY SERVICES) and sample drop off entry (LABORATORY SERVICES). Exact wording to be verified by owner and to include City of Arlington flying "A" logo.
 4. Messenger exterior wall mount signs provide 4 panels, 6" H x 15" mounted adjacent to exterior doors for "Mechanical, Electrical, Fire Riser and Cylinder Room".
- C. Interior Signage: : Jigsaw Interior wall mounted signs with raised letters and braille by ASI Sign Systems

2.2 MATERIALS

- A. Exterior signs of front-loading interchangeable aluminum panels with baked polyester enamel finish.
- B. Flat interior panels approximately 6" H by 8" W, materials frosted acrylic and aluminum, color and letter styles selected from manufacturers standard options. Attach sign panels to wall rails with locking system.

2.3 SCHEDULES

- A. Typical Signage Configuration: Unless otherwise indicated, use Individual Helvetica letters, 1 inch high, identifying room name and room number, with room name on first line, and room number on second line. The exact names, numbers, and final sign configuration shall be as directed by the Architect/Owner.
- B. Provide one sign adjacent to all interior door openings
- C. Rest Room Door Graphics: 6 inches high, "male" and "female" or "Unisex" graphic image; located on each rest room door.
- D. Exterior signs as noted above.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install signs level, plumb, and at the height directed, with sign surfaces free from distortion or other defects in appearance.

3.2 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION

SECTION 10 21 13

PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes solid-plastic toilet compartments configured as toilet enclosures and urinal screens.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachment details.
- C. Samples for each type of toilet compartment material indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 75 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Accurate Partitions Corp., an ASI Group Company.
 2. General Partitions Mfg. Corp.
 3. Global Partitions Corp., an ASI Group Company.
 4. Scranton Products.

Toilet-Enclosure Style: Ceiling hung.

- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
 2. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainless-steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
 3. Color and Pattern: in each room as selected by Architect from manufacturer's full range.
- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- D. Brackets (Fittings):
1. Stirrup Type: Ear or U-brackets, stainless steel.
- E. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from solid polymer.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
1. Material: Stainless steel.
 2. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
- B. Hardware and Accessories: Manufacturer's heavy-duty stainless-steel operating hardware and accessories.
1. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
- C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for

through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Ceiling-Hung Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch-wide, in-swinging doors for standard toilet compartments and 36-inch-wide, out-swinging doors with a minimum 32-inch-wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
 - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION

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SECTION 10 28 00
TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Toilet accessory items, as scheduled on the drawings.
- B. Related sections:
 - 1. Section 10 21 13 - Toilet Compartments.

1.2 QUALITY ASSURANCE

- A. Inserts and Anchorages: Furnish accessory manufacturers' standard inserts and anchoring devices that must be set in concrete or built into masonry. Coordinate delivery with other work to avoid delay.
- B. Single Source Responsibility: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise acceptable to the Owner.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each toilet accessory item specified, including construction details relative to materials, dimensions, gages, profiles, mounting method, specified options, and finishes.
- B. Setting Drawings: Furnish setting drawings where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.

1.4 PROJECT CONDITIONS

- A. Coordinate accessory locations, installation, and sequencing with other work to avoid interference with, and ensure proper installation, operation, adjustment, cleaning, and servicing of toilet accessory items.

1.5 WARRANTY

- A. Submit a written warranty executed by mirror manufacturer, agreeing to replace any mirrors that develop visible silver spoilage defects within warranty period.
 - 1. Warranty Period: 15 years from date of substantial completion.

- B. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Products of the following manufacturer:
1. Bobrick Washroom Equipment, Inc.

2.2 MATERIALS GENERAL

- A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 0.034-inch (22 gage) minimum thickness.
- B. Brass: Leaded and unleaded, flat products, ASTM B 19; rods, shapes, forgings, and flat products with finished edges, ASTM B 16; castings, ASTM B 30.
- C. Sheet Steel: Cold-rolled, commercial quality ASTM A 366, 0.04-inch (20-gage) minimum. Surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A 527, G60.
- E. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.
- F. Baked Enamel Finish: Factory-applied, gloss white, baked acrylic enamel coating.
- G. Mirror Glass: Nominal 6.0-mm (0.23-inch) thick, conforming to ASTM C 1036, Type I, Class 1, Quality q2, and with silvering, electro-plated copper coating, and protective organize coating.
- H. Stainless Steel Mirror Surfaces: Not less than 0.04-inch (20-gage) AISI Type 302/034 stainless steel sheet, stretcher-leveled with No. 8 polished mirror finish. Bond to 1/4-inch minimum hardboard backing.
- I. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
- J. Fasteners: Screws, bolts and other devices of same material as accessory unit, or of galvanized steel where concealed.

2.3 TOILET ACCESSORIES

- A. As indicated on the Drawings.

2.4 FABRICATION

- A. General: Only a maximum 1-1/2-inch-diameter, unobtrusive stamped manufacturer logo, as approved by Owner, is permitted on exposed face of toilet accessory units. On either interior surface not exposed to view or back surface, provide additional identification by either a printed, waterproof label or a stamped nameplate, indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.
- C. Recessed Toilet Accessories, General: Except where otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors or access panels with full-length, stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.
- D. Framed Mirror Units, General: Fabricate frames for glass mirror units to accommodate wood, felt, plastic, or other glass edge protection material. Provide mirror backing and support system that will permit rigid, tamperproof glass installation and prevent moisture accumulation, as follows:
 - 1. Provide galvanized-steel backing sheet, not less than 0.034-inch (22-gage) and full mirror side, with nonabsorptive filler material. Corrugated cardboard is not an acceptable filler material.
- E. Keys: Provide universal keys for access to toilet accessory units requiring internal access for servicing, resupply, etc. Provide minimum of six keys to Owner's representative.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install toilet accessory units according to manufacturer's instructions, using fasteners appropriate to substrate as recommended by unit manufacturer. Install units plumb and level, firmly anchored in locations and at heights indicated.
- B. Secure mirrors to walls in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, according to manufacturer's instructions for type of substrate involved.
- C. Install grab bars to withstand a downward load of at least 250 lbf, complying with ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

- B. Clean and polish all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings.

END OF SECTION

SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire protection cabinets including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.5 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B.
- B. Acrylic Bubble: One piece.

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Clear Bubble Front, suitable for 10 gallon fire extinguisher. Other cabinet sizes may be required depending on Owner's final selection of fire extinguisher type and size.
 - 1. Surface Mounted Cabinets for concrete block walls at Mechanical room and Extruder room: Larsen's Manufacturing Co. Cameo Series C2409-SM.
 - 2. Semi-recessed Cabinets for non-fire-rated gypsum board partitions: Larsen's Manufacturing Co. Cameo Series C2409-R.
 - 3. Semi-recessed Cabinets for fire-rated gypsum board partitions: Larsen's Manufacturing Co. Cameo Series FS-C2409-R, "Flame-Shield" option. Install per manufacturer's detailed directions for "Two Hour Wall System."
- B. Cabinet Material: Steel.
- C. Cabinet Trim Material: Same material and finish as door.
- D. Door Material: Steel/vacuum-formed acrylic bubble.
- E. Door Style: Clear bubble with steel frame.
 - 1. Glazing:
 - a. Acrylic Sheet Color: Clear transparent acrylic sheet with frame.
- F. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide manufacturer's standard
 - 2. Provide concealed hinge permitting door to open 180 degrees.
- G. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Lettered door with the word "FIRE EXTINGUISHER" embossed on the inside face of convex clear bubble.
- H. Finishes:
 - 1. Steel: White baked enamel.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Provide factory-drilled mounting holes.
 - 3. Prepare doors and frames to receive locks.
 - 4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 - 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 STEEL FINISHES

- A. White baked enamel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
 - 1. Fire Extinguisher Cabinets: 27 inches above finished floor to bottom of cabinet to meet ADA guidelines.
- B. Fire Extinguisher Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 10 50 20

CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. TYPE 1: Building / Post supported, pre-engineered metal canopy including fascia channels, decking, posts, post base plates and attachment hardware.
 - 2. TYPE 2: Building supported, pre-engineered metal canopies including fascia channels, decking, tension rods, and attachment hardware.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

- A. Aluminum Association (AA) DAF 45 – Designation System for Aluminum Finishes.
- B. American Architectural Manufacturers Association (AAMA)
 - 1. 2603 – Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Architectural Extrusions and Panels.
- C. American Society of Civil Engineers (ASCE) 7 – Minimum Design Loads for Buildings and Other Structures.
- D. ASTM International (ASTM)
 - 1. 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 2. B429 - Standard Specification for Aluminum-Alloy Extruded Pipe and Tube.

1.3 SYSTEM DESCRIPTION

- A. Design Requirements: Design canopy system to withstand:
 - 1. Standards for wind pressure, snow load, and drifting snow load in accordance with current adopted form of the Uniform Construction code or accepted requirements of local municipality.

1.4 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Indicate system components, dimensions, attachments, and accessories.
 - 2. Samples:
 - a. 3 x 3-inch coating samples in specified color.
 - b. 6-inch-long fascia extrusion sample showing profile and standard finish.
 - c. 6-inch decking samples showing profile and standard finish.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 5 years' experience in installation of MASA products.

1. (Mockup: provide mockup of canopy system including all framing members, supports, decking, hanger rods, and attachments at location selected by architect.)

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Contract Documents are based on: Extrudeck Series
By: MASA Architectural Canopies
21 Randolph Ave.
Avenel, NJ 07001
800-761-7446
www.architecturalcanopies.com
- B. Acceptable alternates: Other manufacturers may bid only after written approval of the Architect, obtained 10 days prior to bid opening and issued by addendum. Interested manufacturers must furnish full details of proposed product, engineering calculations on all sections involved, physical samples of all shapes and finishes, a list of installations similar in size and design, and must have a minimum of five years' experience in manufacturing and installing glazed canopy systems.

2.2 MATERIALS

- A. Aluminum Extrusions:
 1. ASTM B221 & ASTM B429 6061-T6511 alloy and temper.
- B. Hardware:
 1. All fasteners shall be (stainless steel) or (zinc coated) for corrosion resistance.

2.3 COMPONENTS

- A. Framing
 1. Type: 8" X .125" Extruded Aluminum "J" Channel (6063-T5)
- B. Decking:
 1. Type: 3" x 6" x .090" Interlocking Extruded Aluminum Flat Soffit Decking (6063-T5)
- C. CMounting
 1. Type 1: Post / Building Supported - 4" x 4" x 1/8" SQU Extruded Aluminum Tube (6061-T6511)
 2. Type 2: Hanger Rod Supported - 3" x 2 1/2" x 1/4" I-Beam Outriggers (6061-T6511) w/3/4"D schedule 40 steel pipe (A500), escutcheon plate – 6 SQU (S):
- D. Profile/ Crown
 1. Type 1 Profile
 - a. Profile Variables – IND LT 12 (D)
 2. Type 2 Profile
 - a. Profile Variables – IND LT 8 (D)
 3. Crown
 - a. Crown Variables None

2.4 ACCESSORIES

- A. Lighting:

1. 4" LED SQU (Standard) W/ Welded Light Box, 5"x 5" x 1/8" Extruded Aluminum SQU Tube (6061-T6511) (See Light spec. for details.)
- B. Drainage:
 1. Type 1: SQU Downspout
 2. Type 2: Diverters (S)
- C. Obscurity Screen Debris Screen Cover – Single Flange 1" x 1" x 1/8" Extruded Aluminum SQU Tube (6061-T6511), Fabric Ferrari Cover Soltis 86 (selected by architect from MASA color choices)

2.5 FABRICATION

Fabricate canopy system in accordance with approved Shop Drawings. Kit canopies to be mechanically assembled with shears stress strength as per engineering. Pre-assembled canopies are shop welded by MASA approved personnel. Drainage system to be concealed type. Covered surfaces direct water to field drilled drain, to be coordinated at site.

2.6 FINISHES

- A. Aluminum:
 1. Pre-Treatment: Pre-treat to ASTM D1730 type B, Method 5 using a multistage chromate process or an approved chrome-free pretreatment process approved by powder coating manufacturer for optimized weather resistance.
 2. Finish coat: AAMA 2603 Thermosetting Polyester Resin-based Powder
 3. Source: Tiger Drylac powder coating or equivalent.
 4. Color: (color) to be selected by architect from MASA color range

PART 3 - EXECUTION

3.1 FIELD DIMENSIONS

- A. Field verify dimensions of supporting structure at site of installation prior to fabrication.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Install components plumb and level, in proper plane, free from warp and twist.
- C. Anchor system to building components; provide adequate clearance for movement caused by thermal expansion and contraction and wind loads.

3.3 ADJUSTING

- A. Touch up minor scratches and abrasions on finished surfaces to match original finish.

END OF SECTION

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11 01 53.33 RELOCATION OF LABORATORY EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide laboratory relocation services that comply with the requirements of this Section. Services provided by moving contractor shall include the packaging, relocation, and installation of laboratory equipment.
- B. All equipment will be moved from the Pierce-Birch Water Treatment Plant Laboratory and Maintenance Building to the John F. Kubala Water Treatment Plant Laboratory and Maintenance building.
- C. Moving contractors shall follow the timeline outlined in Section 1.03B for all equipment listed in the Schedules at the end of this Specification.
- D. Comply with applicable specifications and standards.

1.02 QUALITY ASSURANCE

- A. Qualifications of Moving Contractor(s):
 - 1. Up to three contractors may be used to complete the laboratory relocation. If a single contractor is to be used for more than one moving classification, that contractor shall be required to demonstrate their ability to meet the qualification requirements listed under each relevant classification below.
 - 2. General Movers
 - a. General movers shall have a minimum of five years of experience moving and installing substantially similar equipment and shall be able to show evidence of at least five office relocations in satisfactory operation for at least five years.
 - b. General movers shall be responsible for all aspects of the relocation, including packaging, moving, and installation of general office and laboratory equipment.
 - c. General movers shall be able to supply all necessary logistics and moving equipment and supplies.
 - 3. Specialty Laboratory Movers
 - a. Specialty laboratory movers shall have a minimum of five years of experience moving and installing substantially similar specialty laboratory equipment and shall be able to show evidence of at least three laboratory relocations in satisfactory operation for at least three years.
 - b. Specialty laboratory movers shall be responsible for all aspects of the relocation, including packaging, moving, and installation of specialty laboratory equipment.
 - c. Specialty laboratory movers shall be familiar with a variety of laboratory environments and their appropriate safety etiquette and PPE.
 - d. Specialty laboratory movers shall be able to supply all necessary logistics and moving equipment and supplies.

4. Glassware Movers

- a. Glassware movers shall have a minimum of five years of experience moving similar glassware and shall be able to show evidence of at least three laboratory relocations in satisfactory operation for at least three years.
- b. Glassware movers shall be responsible for all aspects of the relocation, including packaging, moving, and unpacking glassware.
- c. Glassware movers shall be able to supply all necessary logistics and moving equipment and supplies.

B. Coordination:

1. A coordination meeting between contractor, movers, consultant, and plant staff shall take place in the week prior to the relocation period.
2. Contractor shall coordinate with owner, plant staff and all movers to ensure that the laboratory relocation is completed in the span of six days, according to the following timeline, which is generic in terms of actual date, but specific in terms of days of the week and times of the day:
 - a. Friday, 4 pm – Existing laboratory is vacated by plant staff and handed over to movers. There will be no restrictions to working hours between this time and the end of the General Moving Period specified below.
 - b. Monday, 8 am – End of General Moving Period: Delivery of personal office equipment and general laboratory equipment is completed by general movers.
 - c. Tuesday, 8 am – End of Specialty Laboratory Equipment Moving Period: Delivery of specialty laboratory equipment is completed by specialty laboratory movers.
 - d. Wednesday, 8 am – End of Glassware Moving Period: Delivery of glassware to general laboratory area is completed and ready for organization by the laboratory staff.

1.03 SUBMITTALS:

A. Statement of qualification of each moving contractor as categorized below:

1. General mover
2. Specialty laboratory equipment mover
3. Glassware mover

B. Relocation instructions for equipment moved by the following contractors and, where needed, coordination letters between the moving contractor and a certified equipment manufacturer representative:

1. Specialty Laboratory Equipment Mover
2. Glassware Mover

1.04 SPECIAL GUARANTEE

- A. Each moving contractor shall provide a special guarantee that ensures, at the option of the owner, the provision of corrections, or removal and replacement of equipment found to be defective due to mishandling in the relocation process.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSPECTION

- A. General contractor and each moving contractor shall itemize and inspect the equipment at the start of each moving period and notify the owner in writing of any defective or missing equipment before the start of the relocation process.
- B. General contractor and each moving contractor shall itemize and inspect relocated equipment at the end of each moving period outlined in Section 1.03-B of this specification.
- C. Losses and damages shall be recorded in writing and sent to the owner and the moving contractor shall immediately begin the correction or replacement process.

3.02 RELOCATION AND INSTALLATION

A. General

- 1. General laboratory equipment shall be relocated and installed at the end of the General Moving Period outlined in Section 1.03-B of this specification.
- 2. Equipment shall be installed in the room specified in the General Mover Equipment Schedule below.

B. Specialty Laboratory Equipment

- 1. Specialty laboratory equipment shall be relocated and installed at the end of the Specialty Laboratory Moving Period outlines in Section 1.03-B of this specification.
- 2. Equipment shall be installed in the room specified in the Specialty Laboratory Equipment Schedule below.
- 3. Equipment shall be installed in accordance with the manufacturer's instructions.

C. Glassware

- 1. Glassware shall be relocated and installed at the end of the Glassware Moving Period outlined in Section 1.03-B of this specification.
- 2. Equipment shall be relocated and unpacked in the room specified in the Glassware Moving Schedule below. It shall be neatly organized in the general laboratory area and left for the laboratory staff to relocate within the laboratory.

3.03 CLEANING AND PROTECTION

- A. Repair, or remove and replace, defective equipment as directed by owner.

- B. Clean general equipment, specialty laboratory equipment and glassware of any dirt collected during the relocation process.
- C. Protect equipment from any damages during relocation process and ensure relocated equipment is not subject to any risk of loss or damage as a result of other work or relocations taking place in the laboratory.

GENERAL MOVER EQUIPMENT SCHEDULE

Name	Manufacturer	Location	Move to Room	Unique ID/ LIMS ID	Equipment Measurements (Front Width x Depth x Height in inches)	Serial #
Refrigerators & Freezers						
Bact Sample Refrigerator	VWR	BacT Lab	J101	FRIDGE13	19 x 17.5 x 33	VWR-901910196340P W-1912-V52
Bact Cultures Refrigerator	Frigidaire	Chemical Storage	J104	FRIDGE4	30 x 32 x 65	BA50530037
Freezer	Westinghouse	Chemical Storage	E105	WASTEFREEZER1	43 x 30 x 35	WB60913949
General Sample Refrigerator	Norlake	General Storage Area	E111	FRIDGE6	78 x 31.5 x 84	17090008
TOC Refrigerator	Sanyo	General Lab	E111	FRIDGE8	18.5 x 18 x 18.5	980412544
After Hours Fridge	Frigidaire	Mechanical Room	B111	FRIDGE1	21 x 21 x 33.5	KA404160124
Metals Refrigerator	Hotpoint	Metals Prep Lab	E109	FRIDGE9	28 x 31 x 67	SV778371
IC Standard Refrigerator	Frigidaire	General Lab	Auction	FRIDGE11	18 x 23 x 33	7280250
Organics Prep Refrigerator	Frigidaire	Organics Prep Lab	C103	FRIDGE10	31 x 30 x 65.5	BA40525145
Semi-volatile Standard Refrigerator	Frigidaire	Organics Prep Lab	C103	FRIDGE2	21.5 x 21 x 33.5	KA34760188
VOC Sample Refrigerator	Sanyo	VOC Lab	H106	FRIDGE3	18.5 x 18 x 33.5	960744509

VOC Standard Refrigerator	Frigidaire	VOC Lab	H106	FRIDGE12	22 x 21 x 34	KA21865014
PT Samples Refrigerator	Norlake	General Lab	E111	FRIDGE15	18.5 x 17.5 33.5	NLS-20221479-2002-V52
IC Standard Refrigerator	Norlake Scientific	IC/TOC	C101	FRIDGE16	23.5 x 25 x 34	Not Delivered Yet
Ovens and Incubators						
Incubator	Thermo Scientific	Bact lab	J104	BACT INC2	25 x 29 x 37.5	42372530
Incubator	Thermo Scientific	BOD area	F103	BOD INC3	34 x 30 x 77	300158393
Incubator	Power Scientific	BOD area	F103	BOD INC1	54 x 31 x 96	D106929
Incubator	Power Scientific	BOD area	F103	BOD INC2	54 x 31 x 96	B050572
Incubator Ambi Hi/Lo	Lab Line	General Storage Area	E111	GEN INC1	32 x 28.5 x 75	0602-0004
Microwave Oven	Sharp	General glass prep	E111	MICROWAVE1	24 x 18 x 13.25	117603
Drying Oven	Lindberg Blue	General lab	E111	OVEN4	35 x 22.5 x 37	T03P-505108-TP
Muffle/Organics Box Furnace, model 126	Fisher Scientific	Organics Prep lab	C103	OVEN1	20.5 x 23 x 29	31100033
Heratherm Oven	Thermo	General Lab	E111	OVEN5	25 x 29 x 38	42321987
Heratherm Oven	Thermo	General Lab	E111	OVEN6	25 x 29 x 38	42321996
Hot plates & Hot blocks						
Hot Plate	Thermolyne	General Lab	E111	HOTPLATE1	8.5 x 11 x 5.5	1070970709130
Hot plate/Stirrer	Fox Scientific	General Lab	E111	HOTPLATE2	8 x 11 x 5.5	20170403121
Hot plates/Stirrer (Cimarec)	Thermo Scientific	BacT Lab	J104	HOTPLATE4	12 x 15 x 4.5	C1769120522408
Hot plates/Stirrer (Cimarec)	Thermo Scientific	Organic Prep	J104	HOTPLATE5	12 x 15 x 4.5	C1769130418256

Hot plate/stirrer	Fox Scientific	General Lab	E111	HOTPLATE6	8 x 11 x 5	BPXOP1009550
Cyanide Hot Block/Mico Distillation A17102	Lachat	Metals Prep	F101	CN HOTBLOCK1	28.5 x 7 x 17	130200002173
Hot Block	Digiprep	Metals Room	E109	METALS HOTBLOCK1	19 x 15 x 10	MSX0513161110
Sandbath/hot plate	VWR	Organic Prep	C103	SANDBATH1	12 x 19 x 18	140918003
Autoclaves, Dishwashers and Water baths						
Autoclave	Market Forge	BacT Lab	J104	AUTOCLAVE1	10 x 25 x 33.5	75532
Sonicator, small	Lab Safety Supply	General Lab	E111	SONICATOR1	6 x 9 x 4.5	2013 0016588
Sonicator, benchtop	Branson	Organic Prep	C103	SONICATOR2	24 x 18.5 x 14.5	RPC120277613E
Sonicator, large	Branson	Organics Prep	C103	SONICATOR3	35 x 23 x 37	ATF18069284
Sonicator, small	Branson	Organics Prep	C103	SONICATOR4	7 x 7 x 7	B54640
Dishwasher, Steam scrubber	LabConCo	Bact lab	J104	BACT WASHER1	24 x 24 x 34	060353148 S
Dishwasher, Steam scrubber	LabConCo	General Washing	F102	GEN WASHER1	24 x 24 x 34	140287936
Dishwasher, Steam scrubber	LabConCo	General Washing	F102	GEN WASHER3	24 x 24 x 34	210208694
Water Bath	Cole Palmer	Bact lab	J104	AGAR BATH2	14.5 x 10 x 9	E119B0357
Water Bath	Cole Palmer	Bact lab	J104	BACT BATH2	14.5 x 10 x 9	E119B0354
Thermo Circulating Water Bath	Thermo Scientific	BacT Lab	J101	PRECISION BATH1	45 x 20.5 x 15	300017971
Thermo Circulating Water Bath	Thermo Scientific	BacT Lab	J101	PRECISION BATH2	45 x 20.5 x 15	300221572
Balances, Centrifuges, Jar Tests						
Centrifuge	IEC Centra CL2	Organic Prep	C103	CENTRIFUGE1	11 x 16.5 x 9.5	42603968

Centrifuge	Benchmark	Organic Prep	J104	CENTRIFUGE2	11.5 x 14 x 9	C320071106000 8
Jar Tester	Phipps and Bird	Gen Lab	E111	JARTEST1	42 x 9 x 23	213060108
Jar Tester	Phipps and Bird	Gen Lab	E111	JARTEST2	42 x 9 x 23	213060109
Org Prep Shaker	Eberbach	Organic Prep	C103	SHAKER1	18 x 11 x 14.5	None
Orbital Shaker	Talboy	Organic Prep	C103	SHAKER2	18 x 21 x 12	161228001
Shaker for GAC	WS Tyler RO Tap	Organic Prep	E111	SHAKER3	35 x 24 x 56	10-4879
Small shake/mixer	Thermolyne	Organic Prep	C103	SHAKER4	4 x 6 x 5	26821484
Vacuum Pumps						
DryVap Pump	GAST	Organics Prep	C103	PUMP1	7 x 12.5 x 10	50-2480-01
Pesticide Extraction Pump	Marathon	Organics Prep	C103	PUMP2	8 x 13 x 8	J13J11009
Chlorphl a pump	GE	Organics Prep	J104	PUMP3	9 x 20 x 13	XTL983130
SVOC GCMS2 Pump	Pfeiffer	Organics Lab	C102	PUMP4	6 x 14 x 11	22042672
TSS Pump	Gast	Gen Lab	E111	PUMP5	10 x 16.5 x 10.5	0394
HEOG Pump	Gast	Gen Lab	F104	PUMP6	8 x 16 x 12	50-2480-01
HEOG Pump	Gast	Metals Prep Lab	F104	PUMP7	8 x 16 x 12	Not Visible
Metal Filtration Pump	Rocker	Metals Prep lab	E109	PUMP8	5 x 11 x 7	167300-11- AEA180
ICPMS Vacuum Pump	Agilent	Metals Lab	E110	PUMP9	14 x 21 x 16	It152D035
VOC Intuvo GCMS1 Pump (Oil-less)	Agilent	VOC Lab	H105	PUMP10	6 x 20 x 11	MY18210054
VOC Agilent GCMS1 Pump	Pfeiffer	VOC Lab	H105	PUMP11	5.5 x 14 x 11	21248603
DryVap Pump	GAST	Organics Prep	C103	PUMP12	10 x 16 x 12	Unknown
SVOC INTUVO GCMS3 PUMP	Agilent	Organics Lab	C102	PUMP13	6 x 20 x 11	MY20340051
pump, not in use	Welch	Organics Lab	E111	PUMP14	5 x 16 x 10	10160000748

Small Vacuum Pump	Barnant	Organics Prep Lab	C103	PUMP15	5 x 12 x 6	572706
Chillers and Ice Maker						
Chiller	VWR/Thermo Scientific	Organics Prep	AUCTION	CHILLER1, out of service	27 x 19 x 19	810002
Chiller	Agilent	Metals Prep	E110	CHILLER2	14.5 x 28 x 23	2U15600173
Chiller	Agilent	Metals Prep	E110	CHILLER3	15 x 33 x 54.5	
Ice Maker	Manitowoc	Glassware Washing	B107	ICEMAKER1	30 x 33 x 54.5	1120172389
Stirrers						
5" stirrer	Corning	BOD area	E111	STIR1	5.5 x 3.5 x 3.5	13101094377
4" stirrer	Cimerac/Thermo Scientific	Organics Lab	E111	STIR2	6 x 7.5 x 5	C1946100401737
5" stirrer	Corning	Metals Lab	E111	STIR3	5 x 5.5 x 3.5	01310194369
7" stirrer	Corning	General Lab	E111	STIR4	8 x 9 x 4	36040603976
7" stirrer	Corning	BOD area	F103	STIR5	7.5 x 6 x 5	None
5' stirrer (round)	Thermo Scientific	Organics Prep	E111	STIR6	6 x 6 x 3	C1685170707237
Stirrer (does not heat)	VWR	General Lab	E111	HOTPLATE3	8 x 11.5 x 3.5	61023070
4" stirrer	Thermo Scientific	General Lab	E111	STIR 9	5.5 x 6 x 5	C1926180403096
7" stirrer, repaired cord	Corning	General Lab	E111	STIR10	7.5 x 6 x 5	None
4" stirrer	Thermo Scientific	General Lab	E111	STIR 8	5.5 x 6 x 5	C1926180403668
Meters & Probes						
BOD Meter	Mantech	General Lab	F103	BOD METER2	9 x 2 x 2	18H100193
BOD DO Probe	YSI	General Lab	F103	BOD DO2	9 x 2 x 2	18J100871
LDO LBOD DO probe	Hach	General Lab	F103	BOD DO3	9 x 2 x 2	1725039002

HQ411d pH/mV Bench meter	Hach	General Lab	E111	LAB PH METER1	9 x 2 x 2	151100018747
Hach HQ440d multi	Hach	General Lab	E111	LAB PH METER2/BOD METER1	9 x 2 x 2	120400069911
PHC301 pH probe	Hach	General Lab	E111	pH probe 4	9 x 2 x 2	190292577562
PHC301 pH probe	Hach	General Lab	E111	pH probe 5	9 x 2 x 2	172022577001
pH Electrode HI1053B	Hanna	General Lab	E111	TA probe 2	9 x 2 x 2	0746142M
Conductivity Meter	Hach Model HQ430d	General Lab	E111	SC LAB2	9 x 2 x 2	181200010818
Hach CDC4010	Hach	General Lab	E111	SCProbe4	9 x 2 x 2	210902583695
Turbidimeter	Hach 2100N	General Lab	E111	LAB TURBIDIMETER1	15.5 x 12 x 6.5	960900002826
Pocket Colorimeter NH3 MONO 6	Hach	Login Area	B107	MONO6	3 x 6 x 1.5	19040A001440
Pocket Colorimeter NH3 MONO 5	Hach	Login Area	B107	MONO5	3 x 6 x 1.5	15060E274699
Pocket Colorimeter Cl Kit 6	Hach	Bact Lab	B107	Cl Kit 6	3 x 6 x 1.5	05100C040370
Pocket Colorimeter Cl Kit 9	Hach	Login Area	B107	Cl Kit 9	3 x 6 x 1.5	11090E182851
Pocket Colorimeter Cl Kit 10	Hach	Login Area	B107	Cl Kit 10	3 x 6 x 1.5	12020E192584

Pocket Colorimeter Cl Kit 11	Hach	Joe Sikes	B107	Cl Kit 11	3 x 6 x 1.5	13010E214507
Pocket Colorimeter Cl Kit 12	Hach	Ashley Wolfe	B107	Cl Kit 12	3 x 6 x 1.5	16030E297156
Pocket Colorimeter Cl Kit 13	Hach	Login Area	B107	Cl Kit 13	3 x 6 x 1.5	20070A001271
Field Turbidimeter	Orion/Thermo Scientific	Login Area	B107	FIELD TURBIDIMETER R1	3.5 x 10 x 3	B-04832
HQ40d multi Field Meter	Hach	Login Area	B107	FIELD MULTIMETER 1	4.5 x 8 x 2	120700075955
HQ30d multi Field Meter	Hach	Login Area	B107	FIELD MULTIMETER 2	4.5 x 8 x 2	131100096036
SL1000 field multimeter	Hach	Login Area	B107	FIELD MULTIMETER 3	4.5 x 8 x 2	20270105590
Intellical Nitrate probe	Hach	login area	B107	NITRATE PROBE1	N/A	200242991125
pHC101 probe	Hach	Login Area	B107	WW7	9 x 2 x 2	202872564227
pHC101 probe	Hach	Login Area	B107	WW10	9 x 2 x 2	211112564452
pHC101 probe	Hach	Login Area	B107	WW8	9 x 2 x 2	203162564921
LDO101 probe DO	Hach	Login Area	B107	FIELD DO2	9 x 2 x 2	101792594019
LDO101 probe DO	Hach	Login Area	B107	FIELD DO3	9 x 2 x 2	200092594240
Micro						
Fluorescence Analysis	Spectroline	Bact Lab	J101	UV LIGHT1	12.5 x 9.5 x 11	1808972/178260 2

Cabinet and Light						
Quanti Tray Sealer	Idexx	Bact Lab	J104	SEALER1	20 x 16 x 13.5	131523011679
Quebec Colony Counter	American Optical	Bact Lab	J104	COUNTER1	11 x 10 x 14	820
Photonmaster Luminometer	Hach/Luminultra	Bact Lab	J104	LUMINOMETER2	3 x 5 x 5	PM11208
Water Polisher	Thermo Scientific	Metal Prep lab	J104	WATER1	11 x 15 x 22	2121841000425
Pipets						
Electronic Metals 200	Transferpipette	Metals Lab	E109	M-200B	12 x 2 x 3	20D64523
Electronic Metals 1000	Transferpipette	Metals Lab	E109	M-1000	12 x 2 x 3	07L56770
Electronic Metals 5000	Transferpipette	Metals Lab	E109	M-5000B	12 x 2 x 3	18C90571
Electronic Metals Acids	Transferpipette	Metals Lab	E109	ACIDS-5000	12 x 2 x 3	18C90567
Electronic IC/TOC 200B	Transferpipette	IC/TOC Lab	C101	IC/TOC-200B	12 x 2 x 3	19G05651
Electronic IC/TOC 1000	Transferpipette	IC/TOC Lab	C101	IC/TOC-1000	12 x 2 x 3	05M96515
Electronic IC/TOC 5000	Transferpipette	IC/TOC Lab	C101	IC/TOC 5000	12 x 2 x 3	18E36320
Manual BOD5000	Transferpipette	BOD Area	E111	BOD-5000b	12 x 2 x 3	18H87964
Electronic General 200B	Transferpipette	General Lab	E111	G-200B	12 x 2 x 3	19C44829
Electronic General 1000	Transferpipette	General Lab	E111	G-1000C	12 x 2 x 3	19G03985
Electronic General 10,000	Transferpipette	Metals Lab	E109	G-10,000	12 x 2 x 3	20G25138

Manual Bact 100	Transferpipette	Bact Lab	J104	BACT-100B	12 x 2 x 3	18E38709
Manual General 1-5mL	Transferpipette	General Lab	E111	G-5000	12 x 2 x 3	08N35080 ?
Manual General 1000B	Transferpipette	General Lab	E111	G-1000B	12 x 2 x 3	02N43825 ?
Manual Bact 1000	Transferpipette	Bact Lab	J104	BACT-1000	12 x 2 x 3	11M05238
air compressor	Speedaire	Mechanical room	H102	COMPRESSOR 1	24 x 18 x 44	AS11611
pipet washer	Labconco	Glassware Washing	F102	PIPET WASHER1	15 x 18.5 x 17	180253854
Dessicators						
Solids dessicator	Boekel	General Lab	E111		22 x 22 x 24.5	None
Weigh Room dessicator	Boekel	VOC	E106		22 x 22 x 24.5	None
HE dessicator	Boekel	Metals	F104		22 x 22 x 24.5	None
CN dessicator	NA	Chemical storage	F101		13 x 13 x 19	None
Cultures dessicator	Lab Conco	Chemical Storage	J104		16 x 15 x 17	None
Office Support Equipment						
Desk, three parts		Joe's office	B104		36 x 24 x 29, 71 x 42 x 30, 78 x 15 x 37	None
2 Bookcases		Joe's office	B104		36 x 13 x 43, 36 x 13 x 67	None
Locker		Joe's office	B104		24 x 24 x 66	None
3 Chairs		Joe's office	B104			None
Desk		Ann's office	B106		72 x 22 x 30	None
Table		Ann's office	B106		90 x 96	None
Filing Cabinet		Ann's office	B106		36 x 24 x 30	None
3 Chairs		Ann's office	B106			None

Desk, three parts		Ashley's office	B105		36 x 24 x 29, 71 x 42 x 30, 78 x 15 x 37	None
Locker		Ashley's office	B105		24 x 24 x 66	None
Bookshelf		Ashley's office	B105		30 x 14.5 x 64	None
3 chairs		Ashley's office	B105			None
Desk		Data Checker	E101		72 x 24 x 30, 15 x 27 x 28	None
Small File Cabinet		Data Checker	E101		14 x 24.5 x 18	None
Locker		Data Checker	E101		30 x 24 x 29	None
2 Tables		Nancy's office	B102		60 x 24 x 29 each	None
2 File Cabinets		Nancy's office	B102		35 x 20 x 28, 36 x 19 x 52	None
5 metal filing cabinets		IT room	E102		15 x 25 x 52 each	None
3 large filling cabinets		Arhive room	E102		36 x 19 x 52 each	None
1 File Cabinets (three-foot wide)		OFFICE AREA	E101		3-foot wide	None
1 Four-Drawer File Cabinet		OFFICE AREA	E101		18.25 x 22 x 52.75	None
2 Book Cases		OFFICE AREA	E101		36 x 22 x 72	None
4 Book Cases		OFFICE AREA	B108		36 x 13 x 42	None
Bookcase		IT room	E102		36 x 72 x 13	None
48 Moving Boxes of Staff Personal Items		OFFICE AREA	B108		16 x 12 x 12 each	None
5 tables		Breakroom	B108		4 are 60 x 24 x 30, 1 is 96 x 24 x 30	None
13 chairs		Breakroom	B108		Small	None

Desk		Breakroom	B108		60 x 24 x 29	None

SPECIALTY LABORATORY MOVER EQUIPMENT SCHEDULE

Name	Manufacturer	Location	Move to Room	Unique ID/ LIMS ID	Equipment Measurements (Front Width x Depth x Height in inches)	Serial #
Instrumentation						
BOD Automated System AutoMax354	Mantech	BOD area	F103	MANTECH BOD1	52 x 30 x 35.5	MT-1J8-107
Mantech PC	hp	BOD area	F103			
Auto Titrator	Hanna	General Lab	E111	HANNA AUTOTITRAT OR1	33 x 25.5 x 26.5	21155003
UV Vis Spectrophotome ter	Hach	General Lab	E111	DR 6000 SPEC1		1619348
GC 7890A	Agilent	VOC lab	H105	VOC GCMS1	48 x 21 x 49	CN11211069
Intuvo and GCMS 1 PC	Dell	VOC lab	H105			2UA7492W9K
Mass Spec 5975C	Agilent	VOC lab	H105	VOC GCMS1	48 x 21 x 49	US11323905
PAL SPME System	Agilent	VOC Lab	H105	VOC GCMS1		CH00444821
Agilent Intuvo 9000 GC	Agilent	VOC Lab	H105	VOC INTUVO GCMS1	23 x 26 x 28	MY18210054
Agilent 5977B Mass Spec	Agilent	VOC Lab	H105	VOC INTUVO GCMS1	23 x 26 x 28	US1815R027
Agilent ICP- OES System	Agilent	Metals Lab	E110	ICP-OES 1		
ICP-OES PC	Agilent	Metals Lab	E110	ICP-OES 1		

Agilent ICP-OES Pump	Agilent	Metals Lab	E110	ICP-OES 1		
Agilent ICP-OES Autosampler	Agilent	Metals Lab	E110	ICP-OES 1		
Lumin Purge & Trap Concentrator	Lumin	VOC Lab	H105	VOC INTUVO GCMS1	9 x 19 x 17.25	US18122010
Teledyne Tekmar AquaTek 100	Teledyne Tekmar	VOC Lab	H105	VOC INTUVO GCMS1	18 x 19 x 30	US18099004
Artel PCS	Artel	VOC lab	H106	ARTEL PCS1		20078
ICS-5000	Thermo Scientific	IC/TOC Lab	C101	ICS1	57.5 x 21.5 x 29	12121542
ICS-5000 PC	Dell	IC/TOC Lab	C101			R13JAN-0009
IC-5000 DP	Thermo Scientific	IC/TOC Lab	C101	ICS1	57.5 x 21.5 x 29	12129050
ICS-5000 EG	Thermo Scientific	IC/TOC Lab	C101	ICS1		1219044
ICS-5000 Autosampler	Thermo Scientific	IC/TOC Lab	C101	ICS1	57.5 x 21.5 x 29	1212585
TOC Analyzer	Shimadzu	IC/TOC Lab	E111	TOC1	35 x 26 x 19.5	H54205000446 AE
TOC PC	Dell	IC/TOC Lab	E111			R13JAN-0009
TOC sampler	Shimadzu	IC/TOC Lab	E111	TOC1	35 x 26 x 19.5	H57115000585
DigiVac Blower (Hood)	SCP Science	Metals Prep	E109	DIGIVAC1	39 x 28 x 26	DVX041844046 7
HE Oil & Grease Analyzer	InfraCal	Metals Prep	F104	HEIR1	7 x 7 x 5	17-0086
Cyanide QuikChem Analyzer	LaChat	Metals Prep	F101	CN ANALYZER1		160400001943

Cyanide PC	Dell	Metals Prep	F101			6310590986
Cyanide QuikChem Autosampler	LaChat/Teledyne Cetac	Metals Prep	F101	CN ANALYZER1		021634A260
ICPMS	Agilent	Metals	E110	ICPMS1	65 x 21 x 25.5	JP15250887
ICPMS PC	hp	Metals	E110			2UA44640KS
ICPMS Autosampler	Agilent	Metals	E110	ICPMS1	65 x 21 x 25.5	US091682A520
Mercury Analyzer	Perkin Elmer	Metals	E110	PEHG1	17 x 16.5 x 32	101S18050701
Mercury PC	Dell	Metals	E110			18569210654
Mercury Autosampler	Perkin Elmer	Metals	E110	PEHG1	17 x 16.5 x 32	102S18041604
Agilent GC ECD 7890B	Agilent	Organics Lab	C102	GC ECD1 out of service	48.5 x 21 x 37	CN15133095
Agilent GC Autosampler	Agilent	Organics lab	C102	GC ECD1 out of service	48.5 x 21 x 37	CN14470005
Agilent GC-MS 7890A	Agilent	Organics Lab	C102	SVOC GCMS2	40.5 x 21 x 37	US12251003
GCMS2 PC	Dell	Organics Lab	C102			L11APR-0108
Agilent MS 5975C	Agilent	Organics Lab	C102	SVOC GCMS2	40.5 x 21 x 37	US12180565
Agilent Autosampler 7693	Agilent	Organics Lab	C102	SVOC GCMS2	40.5 x 21 x 37	CN18120006
Agilent Intuvo 9000 GC	Agilent	Organics Lab	C102	SVOC INTUVO GCMS3		US30290001
SVOC Intuvo GCMS3 PC	hp	Organics Lab	C102			
Agilent 5977B Mass Spec	Agilent	Organics Lab	C102	SVOC INTUVO GCMS3		US2041M041

7693A Autosampler Injection System (tray)	Agilent	Organics Lab	C102	SVOC INTUVO GCMS3		US20380287
7693A Autosampler Injection System (injector)	Agilent	Organics Lab	C102	SVOC INTUVO GCMS3		US20430376
O&G Extractor	Horizon SPE- DEX 3100	Metals Prep	F104	HE EXTRACTOR1	7 ft hood	17-0181
O&G Concentrator	Horizon Speed Vap IV	Metals Prep	F104	HE EVAPORATOR 1	14 x 17 x 6.5	17-0086
O&G Extractor	Horizon SPE- DEX 3100	Metals Prep	F104	HE EXTRACTOR2		18-0259
Horizon Dry Vap Concentration System	Horizon	Organics Prep Lab	C102	SVOC CONCENTRAT OR1		16-1456
Metrohm IC System	Metrohm	Organics Lab	C101	ICS2		1930200084532
Metrohm IC System PC	hp	Organics Lab	C101	ICS2		1930200084532

GLASSWARE MOVER EQUIPMENT SCHEDULE

Name	Manufacturer	Location	Move to Room	Unique ID/ LIMS ID	Equipment Measurements (Front Width x Depth x Height in inches)	Serial #
Balances, Centrifuges, Jar Tests						
Balance	Ohaus	Metals Prep	J104	SCOUT BAL1	9 x 7 x 3	BJ056723
Balance	Sartoris	Chemical storage room	F104	SARTORIUS BAL1	8 x 12 x 12	40247331
Balance	Mettler	VOC Lab	E106	METTLER BAL1	11 x 18 x 13	1125412178
Micro						
Microscope	Nikon	Bact Lab	J102	BACT SCOPE1	11 x 19 x 23	134388
Binocular Microscope	Swift	Bact Lab	J102	BACT FIELD SCOPE1	8 x 11 12	10005208
Miscellaneous						
5000 pieces of miscellaneous glassware	N/A	Throughout all labs	E111	N/A	N/A	N/A

END OF SECTION

SECTION 11 53 13

LABORATORY FUME HOODS AND RELATED PRODUCTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Based on Kewaunee Scientific Corporation's Supreme Air Venturi Series fume hood design, furnish and install all fume hoods, work tops, and understructures. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.
- B. Accessorizing:
 - 1. Furnishing and delivering all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings. Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed per section 2.01.J.
- C. Removal of all debris, dirt and rubbish accumulated as a result of the installation of the fume hoods to an on-site container provided by others, leaving the premises clean and orderly.
- D. Related Divisions:
 - 1. Division 12: Laboratory Casework
 - 2. Division 22: Plumbing
 - 3. Division 23: HVAC
 - 4. Division 26: Electrical
 - 5. Related Publications: ASHRAE Standard 110.2016 - Method of Testing Performance of Laboratory Fume Hoods.
 - 6. NIH03-112C - National Institute of Health Specification
 - 7. UL - Underwriters Laboratories
 - 8. ASTM D552 - Bending Test
 - 9. NFPA-45 - National Fire Protection Association

1.2 BASIS OF WORK

- A. It is the intent of this specification to use Kewaunee Scientific Corporation, Statesville, North Carolina, as the standard of construction for laboratory fume hoods. The construction standards of the Kewaunee Supreme Air Venturi fume hood shall provide the basis for quality and functional installation.
- B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval. This approval must be obtained seven (7) days before the proposal deadline.

- C. General Contractors should secure a list of approved fume hood manufacturers from the architect as a protection against non-conformance to these specifications.
- D. The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.
- E. Submittals:
 - 1. Manufacturer's Data:
 - 2. Submit manufacturer's data and installation instructions for each type of fume hood. Provide data indicating ASHRAE Standard 110.2016 has been successfully completed per section 1.02 C along with manufacturers "As Manufactured" testing procedure.
 - 3. Samples:
 - 4. Samples if called for will be reviewed for color, texture, and pattern only. Submit the following:
 - a. Hood interior lining, 6 by 6 inches.
 - b. Hood enclosure, 6 by 6 inches, of color selected
 - c. Operation sign(s).
 - 5. Shop Drawings:
 - a. Submit shop drawings for fume hoods showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings:
 - b. Coordinate shop drawings with other work involved.
 - c. Provide roughing-in drawings for mechanical and electrical services when required.
 - d. Provide face opening, air volume, and static pressure drop data.
 - 6. Non-Specified Manufacturer's Samples:
 - a. A sample from each non-specified manufacturer will be required and reviewed per specification. This sample shall be delivered, at no cost to the architect or owner to a destination set forth by the architect or owner. The sample must then be tested per section 1.02.C by an independent test agency hired by the submitting company and approved by the owner/architect. A passing test and owner/architect approval of the prototype must be written and approved seven (7) days before quotation deadline as a condition of acceptance for any quotation participant.

1.3 STANDARD FUME HOOD PERFORMANCE REQUIREMENTS

- A. Fume hoods shall be Kewaunee's Supreme Air Venturi model with belted counterweight sash design, electronic sash stop and adjustable LED lighting. Sash and air entry framework of the hood shall minimize eddying of air currents at the hood face, and vertical rear baffle system shall minimize turbulence and vortexes in all portions of the hood interior.
- B. Standard Venturi Fume Hood Types
 - 1. Variable Air Volume (VAV) Fume Hood:
 - a. VAV Fume Hood designed to yield FPM face velocity at " sash opening
 - b. Notched belt and sprocket sash system

- c. Electronic sash stops at 18"
- d. LED lighting, with variable intensity and color range
- e. Unobstructed viewing height to be minimum 38.5"

C. Containment:

1. The purpose of this specification is to pre-qualify the performance of the bidder's laboratory fume hood before award of contract. At their option, owners or their representatives may require the same tests to be performed and the same performance be achieved before acceptance of the hood after award of contract. The owner or their representative shall witness the tests. Failure to meet the performance specified shall be cause for rejection of the bidder.
2. Test Method:
3. The hood shall be tested per the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 110-2016.
4. Location of Tests and Test Facility: All tests referenced herein shall be performed in the bidder's fume hood test facility. Field-testing is described in Section 3.01.F.
5. The test facility shall meet the following requirements:
 - a. The test facility shall have sufficient area so that a minimum of 5 feet of clear space is available in front of and on both sides of the hood for viewing tests.
 - b. The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired ranges.
 - c. Standard room air currents in the test area shall be less than 15 FPM.
 - d. The hood exhaust system shall be properly calibrated so that the desired exhaust air volumes can be easily attained.
 - e. Make-up air to the test room shall be ceiling-supplied as in a standard chemical laboratory.
6. Instrumentation, Equipment and Test Personnel:
 Qualified personnel to perform the tests shall be supplied by the bidder. Instrumentation and equipment required shall be supplied by the bidder at their expense. Required instrumentation shall include but not be limited to the following items:
 - a. Thermal anemometer capable of measuring air velocities from 10 to 600 ft./minute
 - b. One-half minute smoke candles or other source of high-volume smoke
 - c. Smoke tubes or other source of localized smoke
 - d. Miran 103 analyzer calibrated to indicate concentration of sulfur hexafluoride or equivalent.
 - e. Flowmeter - 15 L/minute capacity
 - f. Tank of sulfur hexafluoride with a two-stage regulator or other tracer gas suitable for detector to be used
 - g. Adjustable mannequin, 5' 0" to 5'8" in height, with reasonable human proportions and arms hanging at its side
 - h. ASHRAE 110-1995 tracer gas ejector
7. ASHRAE Test (Choose One):

- a. Standard 110-2016 Test
Hood shall be tested with a face velocity of 50 FPM with the sash at the maximum opening, 28". The hood shall have a performance rating in the static portion of ASHRAE 110-2016 (Section 7.1-7.10) of AM 0.01 or better wherein:
4.0 = tracer gas release in liters/minute AM = as manufactured
0.01 = 5-minute time average level of control of tracer gas in parts per million (PPM)
 - b. Standard 110-2016 Test
Hood should be tested with the sash at the maximum opening 28"s, with a face velocity that corresponds to the volume indicated in Paragraph 1.02 B. The hood shall have a performance rating in the static portion of ASHRAE 110-1995 (Section 7.1-7.10) of AM 0.01 or better wherein:
4.0 = tracer gas release in liters/minute AM = as manufactured
0.01 = 5-minute time average level of control of tracer gas in parts per million (PPM)
- 8. ASHRAE 110-2016 Perimeter, Sash Movement Tests, and Cross Draft Requirements:
 - a. The hood shall have a maximum perimeter reading (Section 7.11) of 0.01 PPM or less.
 - b. The hood shall have a maximum sash movement value (Section 7.12) of 0.05 PPM or less.
- 9. Twisting Manikin Test
 - a. A manikin mounted to a twisting base will be placed in standard ASHRAE 110 position. Arms will be altered to hold objects similar in dimension to two 600 ml beakers inside the hood. Manikin twist angle will be such that at the extreme right and left rotational positions, one "beaker" is outside the sash plane. At a rotation rate of 4 cycles per minute, a four-minute run will be undertaken with a sensor in the manikin breathing zone. Average breathing zone concentration shall remain less than 0.05 PPM.

1.4 QUALITY ASSURANCE

- A. The laboratory fume hood manufacturer shall provide fume hood work tops and casework all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.
- B. General Performance: Provide certification that fume hoods meet the performance requirements described in section 1.02.C.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The basis of this specification is the Supreme Air Venturi fume hood as manufactured by Kewaunee Scientific Corporation, 2700 West Front Street, Statesville, North Carolina.

- B. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific shall contain a review of the following capabilities:
1. List of shop facilities
 2. List of engineering and manufacturing personnel
 3. Proof of financial ability to fulfill the contract
 4. List of a minimum of ten installations over the last five years of comparable scope
 5. Proof of project management and installation capabilities
- C. The selected manufacturer must warrant for a period of one-year starting (date of acceptance or occupancy, whichever comes first) that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.2 MATERIALS AND CONSTRUCTION

- A. Fume Hood Superstructure Frame:
1. A structure of steel support members shall be provided to support exterior panels and interior liner and baffle panels. To allow for maintenance and replacements, the baffle panels shall be removable without disassembly of the frame structure and outer steel panels. Likewise, the exterior steel panels shall be removable without disassembly of the frame structure and inner liner panels.
- B. Fume Hood Side Walls:
1. Double wall ends, not more than 4.5" wide, with sash track flush with front vertical fascia, shall be provided to maximize interior working area. This fascia shall contain space for the required service controls and electrical devices. The front vertical fascia shall be in a plane 45 degrees from the hood face and incorporate a Venturi port to provide accelerating air through the lower corners of the face opening.
- C. Fume Hood Dimensions:
1. Double wall end panel thickness shall not exceed 4.5". Interior clear working height shall be not less than 48" at any location in the interior of the hood on bench hoods. Interior depth from the back of the sash to the front of the rear baffle shall not be less than 24". The sash opening shall be not less than 28" in height above the worksurface on bench hoods.
- D. Fume Hood Airfoil:
1. A 12-gauge painted steel, (optional stainless steel) convergence z-cross section airfoil shall be mounted flush to the worksurface immediately in front of the sash plane. It shall nest into the Venturi port on each side, and provide no open space between it and the top front edge of the worksurface. Raised airfoils, or flush designs that create openings within the hood chamber, are not acceptable.

- E. Fume hood top panel shall incorporate a Venturi type dynamic barrier bypass providing a clean air stream behind the sash plane.
- F. Fume Hood Baffles:
 - 1. The fume hood baffles shall be fixed and constructed of the same material as the hood lining. They shall consist of multiple sections with vertical slots and a continuous horizontal slot at the worksurface. Each baffle panel shall be easily removable from the interior, without the use of tools, or requiring liner disassembly. Mechanical or manually adjustable baffles are not acceptable.
- G. Fume Hood Duct Collar:
 - 1. Each fume hood up to six feet in length shall contain one (1) 12" diameter FRP (optional stainless steel) duct collar in the hood roof for exhausting the hood. Fume hoods over six feet in length shall contain two (2).
- H. Fume Hood Lighting:
 - 1. An LED light fixture of the size given below shall be provided in the hood roof. The light shall provide (15) intensity adjustment levels, and (3) color options. Illumination at the worksurface shall be at 100 foot-candles at the full intensity setting. The light fixture shall be isolated from the hood interior by a 1/4" thick tempered glass panel sealed from the hood cavity. Fixture shall be UL listed.
- I. Fume Hood Vertical Sash:
 - 1. A vertical rising sash of 1/4" laminated safety glass shall be provided. The sash shall have a neutral colored polyvinyl chloride horizontal member at the top and a painted full-length aerodynamic aluminum support rail with integral finger pull at the bottom. The sash shall be counterbalanced with a single weight to prevent tilting and binding during operation. The sash shall be connected to the counterweight system with two, 1/2" wide steel-reinforced polyurethane notched belts that engage two sprocket shaft drives. The sash shall provide a 38-1/2" viewing height, with a maximum opening of 28".
- J. Fume Hood Vertical Sash:
 - 1. Rod Type Remote Control Fittings:
 - a. Service fitting valves shall be needle valve design and be mounted to the hood interior sidewall liner with extension rods to the front vertical fascia. Valves shall be furnished with molded nylon handles with color-coded index buttons and color-coded service outlet.
- K. Fume Hood Electrical Fixtures:
 - 1. The hood superstructure shall be pre-wired and contain a UL label certifying acceptable wire gauge, connections, fixtures and wire color-coding. Electrical fixtures shall be specification grade and consist of two side-by-side duplex receptacles per vertical fascia, and a light switch. The receptacles shall be 20 Amp., 125 volt AC, and 3-wire polarized grounded. Each fascia shall be prewired to a single circuit and have a minimum of (1) ground fault interruption device. The light, light switches and electronic sash stop shall be low voltage. Final wiring and circuit dedication shall be by others.

- L. Hood Worksurface:
1. The hood worksurface shall be 1-1/4" thick molded epoxy resin made in the form of a watertight pan, not less than 1/2" deep to contain spillage. Top shall be manufactured at the same manufacturing location as the fume hood to assure proper cutout alignment and coordinated shipping. An undermount sink flush with the recessed worksurface, shall be provided when shown.
- M. Interior Service Access:
1. Access to services shall be through a trapezoid shaped gasketed panel constructed of the same material as the liner. The panel shall be easily removable without the use of tools.
- N. Fume Hood Liners:
1. KEMGLASS Fiberglass Reinforced Polyester Lining:
 - a. Interior liner panels shall be 1/4" thick fiberglass reinforced polyester sheet. Interior liner panels shall be fastened using stainless steel screws with plastic covered heads. The material shall have an ASTM E84 Class A flame spread rating (25 or less).
- O. Fume Hood Base Cabinets
1. Standard Steel: Unless otherwise indicated base units under hoods shall be fabricated of cold rolled prime grade roller leveled furniture steel. Gauges of steel used in construction shall be 18 gauge except as follows:
 - a. Corner gussets for leveling bolts and apron corner braces, 12 gauge.
 - b. Hinge reinforcements, 14 gauge.
 - c. Top and intermediate front horizontal rails, apron rails and reinforcement gussets, 16 gauge.
 - d. Door assemblies and adjustable shelves, 20 gauge.
 - e. Performance of the painted surfaces shall match that of the fume hood outer panels.
 2. Special Purpose Cabinets for Use Under Fume Hoods:
 - a. Acid Storage Cabinets:

Where indicated acid storage cabinets shall use the same gauges of steel and construction features as other base cabinets. In addition, they shall have a one-piece liner insert made of linear low-density polyethylene.

The liner insert shall form a one-inch pan at the bottom to retain spillage. Each door will have a set of louvers at the top and bottom. The door shall be lined with a polyethylene sheet. Each cabinet shall be vented into the fume hood with a 1-1/2" flexible vent pipe, providing a positive airflow directly into the fume hood exhaust system.
 - b. Solvent Storage Cabinets:

Solvent storage cabinets shall be FM or UL labeled and specifically designed for the storage for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UFC, OSHA, and NFPA No. 30 - 2003. The bottoms, top, sides and doors shall be fabricated of 18-gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated.

The right hand door shall be equipped with a three point latching device and the left-hand door shall have a full height astragal. The doors shall be self-closing and synchronized so that both doors will always fully close. The right hand door shall be equipped with a three-point latching system that automatically engages when the doors close. Each door shall be equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long shall have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A full-depth adjustable shelf shall also be provided. The shelf shall be perforated to allow air circulation within the cabinet. Two diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw. The cabinet shall have an interior finish the same as the exterior and shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".

P. Power Sash Controller:

1. A push button sash controller (Kewaunee PSC1000) shall allow one button up and down electronic sash control

Q. Fume Hood Finish:

1. After the component parts have been completely welded together and before finishing, they shall be given a pre paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals. After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.
The completed finish in standard colors shall meet the performance test requirements specified under section 2.3.A Steel Paint Finish Performance Test Results.

2.3 PERFORMANCE REQUIREMENTS

A. Steel Paint Finish Performance Test Results (Chemical Spot Tests):

1. Testing Procedure:
 - a. Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated

with reagent on the surface to be tested and covering with an inverted 2 ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77 degrees $\pm$ 3 degrees F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

2. Test Evaluation:
 - a. Evaluation shall be based on the following rating system. Level 0-No detectable change.
 Level 1 - Slight change in color or gloss.
 Level 2 - Slight surface etching or severe staining.
 Level 3 - Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.
 - b. After testing, panel shall show no more than three (3) Level 3 conditions.
3. Test Reagents:

Test No.	Chemical Reagent	Test Method
a.	Acetate, Amyl	Cotton ball & bottle
b.	Acetate, Ethyl	Cotton ball & bottle
c.	Acetic Acid, 98%	Watch glass
d.	Acetone	Cotton ball & bottle
e.	Acid Dichromate, 5%	Watch glass
f.	Alcohol, Butyl	Cotton ball & bottle
g.	Alcohol, Ethyl	Cotton ball & bottle
h.	Alcohol, Methyl	Cotton ball & bottle
i.	Ammonium Hydroxide, 28%	Watch glass
j.	Benzene	Cotton ball & bottle
k.	Carbon Tetrachloride	Cotton ball & bottle
l.	Chloroform	Cotton ball & bottle
m.	Chromic Acid, 60%	Watch glass
n.	Cresol	Cotton ball & bottle
o.	Dichlor Acetic Acid	Cotton ball & bottle
p.	Dimethylformamide	Cotton ball & bottle
q.	Dioxane	Cotton ball & bottle
r.	Ethyl Ether	Cotton ball & bottle
s.	Formaldehyde, 37%	Cotton ball & bottle
t.	Formic Acid, 90%	Watch glass
u.	Furfural	Cotton ball & bottle
v.	Gasoline	Cotton ball & bottle
w.	Hydrochloric Acid, 37%	Watch glass
x.	Hydrofluoric Acid, 48%	Watch glass
y.	Hydrogen Peroxide, 3%	Watch glass
z.	Iodine, Tincture of	Watch glass
aa.	Methyl Ethyl Ketone	Cotton ball & bottle
bb.	Methylene Chloride	Cotton ball & bottle

- cc. Mono Chlorobenzene Cotton ball & bottle
- dd. Naphthalene Cotton ball & bottle
- ee. Nitric Acid, 20% Watch glass
- ff. Nitric Acid, 30% Watch glass
- gg. Nitric Acid, 70% Watch glass
- hh. Phenol, 90% Cotton ball & bottle
- ii. Phosphoric Acid, 85% Watch glass
- jj. Silver Nitrate, Saturated Watch glass
- kk. Sodium Hydroxide, 10% Watch glass
- ll. Sodium Hydroxide, 20% Watch glass
- mm. Sodium Hydroxide, 40% Watch glass
- nn. Sodium Hydroxide, Flake Watch glass
- oo. Sodium Sulfide, Saturated Watch glass
- pp. Sulfuric Acid, 33% Watch glass
- qq. Sulfuric Acid, 77% Watch glass
- rr. Sulfuric Acid, 96% Watch glass
- ss. Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts Watch glass
- tt. Toluene Cotton ball & bottle
- uu. Trichloroethylene Cotton ball & bottle
- vv. Xylene Cotton ball & bottle
- ww. Zinc Chloride, Saturated Watch glass

* Where concentrations are indicated, percentages are by weight.

4. Performance Test Results (Heat Resistance):
 - a. Hot water (190 degrees F - 205 degrees F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45 degrees from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.
5. Performance Test Results (Impact Resistance):
 - a. A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.
6. Performance Test Results (Bending Test):
 - a. An 18-gauge steel strip, finished as specified, when bent 180 degrees over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.
7. Performance Test Results (Adhesion):
 - a. Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197 68, "Standard Method of Test for Adhesion of Organic Coatings".
8. Performance Test Results (Hardness):

- a. The test sample shall have a hardness of 4 H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8 H is the hardest, and next in order of diminishing hardness are 7 H, 6 H, 5 H, 4 H, 3 H, 2 H, F, HB, B (soft), 2 B, 3 B, 4 B, 5 B (which is the softest). The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel like manner until one is found that will cut or scratch the film. The pencil used before that one that is, the hardest pencil that will not rupture the film is then used to express or designate the hardness.

B. Fume Hood Liner Performance:

1. Chemical Spot Tests - 24 Hours:
 - a. Chemical spot test shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.
2. Legend / Ratings:
 - a. KMER (Kewaunee Modified Epoxy Resin) A = No effect or slight change in gloss
 - b. Glass Reinforced Polyester B = Slight change in gloss or color
 - c. Stainless Steel 304 C = Slight etching or severe staining
 - d. Stainless Steel 316 D = Swelling, pitting, or severe etching
 - e. Reinforced Phenolic Resin
3. RESULTS: 1 2 3 4
 - a. Acetic Acid 98% A C B B A
 - b. Acetone ** A A A A A
 - c. Acid Dichromate A B A A A
 - d. Ammonium Hydroxide ** 28% A A B B A
 - e. Amyl Acetate ** A A A A A
 - f. Benzene ** A A A A A
 - g. Butyl Alcohol ** A A A A A
 - h. Carbon Tetrachloride ** A B A A A
 - i. Chloroform ** A B A A A
 - j. Chromic Acid 60% B C C C A
 - k. Cresol A A A A A

l.	Dichloroacetic Acid	A	A	B	A	A
m.	Dimethylformamide	A	A	A	A	A
n.	Dioxane **	A	A	A	A	A
o.	Ethyl Acetate **	A	A	A	A	A
p.	Ethyl Ether **	A	A	A	A	A
q.	Ethyl Alcohol **	A	A	A	A	A
r.	Formaldehyde	A	A	A	A	A
s.	Formic Acid 90%	A	B	A	A	A
t.	Furfural **	B	C	A	A	C
u.	Gasoline **	A	A	A	A	A
v.	Hydrochloric Acid 37%	A	A	B	B	A
w.	Hydrofluoric Acid 48%	B	A	D	D	A
x.	Hydrogen Peroxide 30%	A	A	A	A	A
y.	Methyl Ethyl Ketone **	A	A	A	A	A
z.	Methyl Alcohol **	A	A	A	A	A
aa.	Methylene Chloride **	A	B	A	A	A
bb.	Monochlorobenzene **	A	A	A	A	A
cc.	Naphthalene **	A	A	A	A	A
dd.	Nitric Acid 20%	B	A	B	A	A
ee.	Nitric Acid 30%	B	B	B	A	A
ff.	Nitric Acid 70%	B	B	B	A	A
gg.	Phenol ** 85%	A	A	A	A	A
hh.	Phosphoric Acid 85%	A	A	B	A	A
ii.	Silver Nitrate	B	C	A	A	C
jj.	Sodium Hydroxide 40%	A	A	A	A	A
kk.	Sodium Hydroxide 20%	A	A	A	A	A
ll.	Sodium Hydroxide 10%	A	A	A	A	A
mm.	Sodium Hydroxide Flake	A	A	A	A	A
nn.	Sodium Sulfide	A	A	A	A	A
oo.	Sulfuric Acid 77%	A	A	C	A	A
pp.	Sulfuric Acid 96%	C	B	C	A	C
qq.	Sulfuric Acid 33%	A	A	C	A	A
rr.	Tincture of Iodine	A	C	B	B	A
ss.	Toluene **	A	A	A	A	A
tt.	Trichlorethylene **	A	A	A	A	A
uu.	Xylene **	A	A	A	A	A
vv.	Zinc Chloride	A	A	B	A	A
ww.	Nitric 70%/Sulfuric Acid 77%*	B	B	B	A	A

* Equal parts of Nitric Acid 70% and Sulfuric Acid 77%.

** Indicates these solvents tested with cotton and jar method

2.4 LOCAL EXHAUST- SNORKEL

- A. Product: Movex ME 4” Ceiling Mounted Local Extractor, Standard edition
- B. Unit shall consist of 4” diameter articulating localized fume extraction arm of three joint designs. Each arm shall be constructed of aluminum tubes with polypropylene joints. The arms are available in six different standard lengths; 46”, 54”, 66”, 76”, 84” and 106”.

- C. The friction joints shall have a low turbulence design to combine maximum flexibility with low pressure drop and low noise level. The variations in pressure drop between an extractor in working position and fully retracted shall be minimal. The 4" diameter extractor arm shall have a recommended pressure drop of 1.0 in/wg at 180 cfm.
- D. Extractor arms in lengths of 46" & 54" shall have internal support springs. Extractor arms in lengths of 66" & 76" shall have (1) external gas spring support. Extractor arms in lengths of 84" & 106" shall have (2) external gas spring supports.
- E. The mounting arrangements shall provide full 360-degree swivel functionality between the aluminum tube and bracket thereby avoiding metal-on-metal contact.
- F. All ceiling mounted extractors are mounted to a single ceiling bracket, eliminating the need of a special joint or flexible connection. Ceiling bracket shall be manufactured in extruded anodized aluminum in a square concave design that can be epoxy coated as optional, making it rigid to support the weight of the arm. The ceiling bracket works both as a stable bracket and a duct up to the connection for the exhaust duct. This solution only requires one hole through the ceiling, thus avoiding an additional ventilation duct to the extractor arm. The takeout shall be made out of polypropylene with gasket to avoid any leakage between the takeout and aluminum profile. Exhaust connection shall be 5" diameter.
- G. The ceiling bracket comes in eight standard lengths up to 80", with longer brackets on request.
- H. The friction joints are running on ball bearing friction contact for easy and convenient positioning. All friction joints rest on chemical resistant plastic O ring seals and have a 6" large friction diameter.
- I. The ball bearing joint tightening mechanism and large diameter sealed joint shall allow 360-degree swivel and easy re-positioning using one hand operation without the use of tools or wrenches. Once adjusted, the extractor shall stay in position without sagging.
- J. The joints shall have reinforced indentations to prevent deformation of the joint and to provide uniform pressure on the O ring joint eliminating slippage of the joint or fracturing of the gable and minimizing position slippage.
- K. Each extractor shall be equipped with an integral, airtight, throttle damper positioned in the pipe suitable for the system pressure.
- L. Provide an equal number of 14" diameter dome hoods, 20" diameter dome hoods, 10" diameter metal hoods, Square hoods (22" x 182") or Square flat screen hoods (15" x 10") to be installed on site.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. The owner and/or his representative shall certify building conditions conducive to the installation of a finished goods product, including all critical dimensions.

3.2 INSTALLATION

- A. Preparation:
 - 1. Prior to beginning installation of fume hood, check and verify that no irregularities exist that would affect quality of execution of work specified.
- B. Coordination:
 - 1. Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.
- C. Performance:
 - 1. Install fume hoods, plumb, level, rigid, securely anchored to building and adjacent furniture in proper location, in accordance with manufacturer's instructions and the approved shop drawings. Provide filler panels between top of hood and ceiling. Securely attach access panels but provide for easy removal and secure reattachment. Do not install any damaged units.
- D. Adjust and Clean:
 - 1. After installations are complete, adjust all moving parts for smooth operation.
 - 2. Remove all packing materials and debris resulting from this work and turn over the fume hoods to the Owner clean and polished both inside and out.
 - 3. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
- E. Protection:
 - 1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
 - 2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.
- F. Certification:
 - 1. Fume Hood Manufacturer shall field test a random sample of 20% of the installed units using ANSI/ASHRAE 110-2016 to a control level of AI 0.02 ppm or better.
 - 2. Project substantial completion shall be withheld until all required fume hood certification letters, tests, and reports have been submitted to and approved by the Architect.

END OF SECTION

SECTION 12 35 53.13

STEEL LABORATORY CASEWORK AND RELATED PRODUCTS

PART 1 - GENERAL

1.1 SUMMARY AND SCOPE

A. Section Includes:

1. Using Kewaunee Scientific Corporation, RESEARCH COLLECTION Laboratory Furniture as a steel casework specification standard, furnish all cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, equipment schedules, and drawings. Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.
2. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches as listed in these specifications, equipment schedules, and drawings, as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, shall be packaged separately and properly marked for delivery to the appropriate contractor.
3. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in these specifications, equipment schedules, and drawings. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
4. Furnish service strip supports where specified, and set in place, service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.
5. Removal of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises broom clean and orderly.

B. Related Divisions:

1. Divisions 5 & 6: Behind-the-Wall Blocking and Studs
2. Division 9: Base Molding
3. Division 11: Chemical Fume Hoods
4. Division 22: Plumbing
5. Division 26: Electrical Fittings and Connections
6. Division 27: Communications

1.2 BASIS OF WORK

- A. It is the intent of this specification to use Kewaunee Scientific Corporation - RESEARCH COLLECTION Laboratory Furniture as the standard of construction for laboratory

furniture. The construction standards of this product line shall provide the basis for quality and functional installation.

- B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval from the owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 1.03.B in this specification.
- C. General Contractors should secure a list of approved laboratory furniture manufacturers from the architect as a protection against non-conformance to these specifications.
- D. Participants in the quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.
- E. The owner/owner's representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.3 QUALITY ASSURANCE

- A. The steel laboratory furniture contractor shall also provide worktops and fume hoods all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.
- B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.
- C. Finish Performance: Provide independent test lab certification that furniture shall meet the performance requirements described in section 2.05 of these specifications.

1.4 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework.
- B. Samples: Samples from non-specified manufacturers will be required and reviewed per specification. Samples shall be delivered, at no cost to the architect or owner, to a destination set forth by the architect or owner. This must be done seven (7) days before quotation deadline as a condition of approval of each bidder. Samples shall be full size, production type samples. Miniature or "Show Room" type samples are not acceptable. Furnish the following:
 - 1. One 18" combination (1) drawer and (1) cupboard base unit showing complete construction details, including (1) shelf
 - 2. One 36" acid storage base cabinet typical of specified elevations
 - 3. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests

4. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware. The architect or owner will retain the above samples of the successful manufacture to insure that material delivered to jobsite conforms in every respect to the samples submitted.
- C. Shop Drawings: Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.
 1. Coordinate shop drawings with other work involved.
 2. Provide roughing-in drawings for mechanical and electrical services when required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The basis of this specification is steel casework manufactured according to the standards used by Kewaunee Scientific Corporation, 2700 Front Street, Statesville, North Carolina. The specified design is Research Collection. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific Corporation shall contain a review of the following capabilities:
 1. List of shop facilities
 2. List of engineering and manufacturing personnel
 3. Proof of financial ability to fulfill the contract
 4. List of a minimum of ten (10) installations over the last five (5) years of comparable scope
 5. Proof of project management and installation capabilities
 6. SEFA member in Good Standing
- B. The selected manufacturer shall warrant that all products be free of defects in material and workmanship for a period of one year. The period shall start at the date of acceptance or occupation, whichever comes first. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.2 CABINET MATERIAL

- A. Steel: Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from cold rolled steel.

2.3 DRAWER AND DOOR STYLE

- A. Overlay Square Edge: Drawer and door, when closed, shall rest against face of cabinet shell, creating a 3/4" overlay front with 1/8" reveal. The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel. The top

front corners of the door shall be welded and ground smooth. Cabinet shall be available with 5-knuckle, semi-concealed or concealed hinges and optional pulls.

2.4 MATERIALS

- A. General Requirements: It is the intent of this specification to provide a high quality steel cabinet specifically designed for the laboratory environment.
- B. Steel:
 - 1. Cold Rolled Steel: Cold rolled sheet steel shall be prime grade 12, 14, 16, 18- and 20-gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.
 - 2. Stainless Steel: Stainless Steel shall be Type 304; 12, 14, 16, 18- and 20-gauge U.S. Standard. Stainless steel shall be supplied with a #4 finish free of burrs, weld marks, or other imperfections.
- C. Composition Core Plywood Composition core plywood shall be 3-ply and shall be compliant with ANSI A208.1-199, and/or ANSI A208.2-1994
- D. Hardware and Trim:
 - 1. Drawer and Door Pulls:
 - a. Drawer and door pulls shall be mounted on 4" centers, offering a comfortable hand grip, and be securely fastened to doors and drawers. They shall be manufactured from: 5/16" diameter chrome plated brass rod with brushed satin finish.
 - b. Sliding Door Pulls: Sliding door pulls shall be Aluminum-Recessed. Finger holes or slots machined into doors will not be acceptable.
 - c. Hinges: (Note: not all hinges meet SEFA 8 specifications) Overlay 5-Knuckle Hinges: 5-Knuckle hinges made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" in height shall be hung on three hinges.
 - d. Drawer Slide: Heavy duty, full extension, soft-close, self-closing, zinc plated, ball bearing slides, rated for 100-pound loads
 - e. Catches - For steel casework with 5-knuckle hinges:
 - 1. Positive Catch: A two-piece heavy-duty cam action positive catch Main body of the catch shall be confined within an integral cabinet top or divider rail, while latching post shall be mounted on the hinge side of door. Polyethylene roller type catches are not acceptable.
 - f. Elbow Catches: Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and are to be burnished cast aluminum, with bright brass finish.
 - g. Shelf Adjustment Clips: Shelf adjustment clips shall be die formed, nickel-plated steel.

- h. Leg Shoes: Leg shoes shall be a pliable, black vinyl material and shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Use of a leg shoe, which does not conceal leveling device, will not be acceptable.
- i. Base Molding: Base molding shall be provided by others.
- j. Label Holders: Label holders, where shown or called for, shall be self-adhesive type aluminum with satin finish and designed for 2-1/2" x 1-1/8" cards, unless otherwise specified.
- k. Number Plates: Number plates, where shown or called for, shall be self-adhesive type aluminum with indented black lettering.
- l. Sink Supports: Sink supports shall be the hanger type, suspended from end panels of sink cabinet by four 1/4" dia. rods, threaded at bottom end and offset at top to hang from two full-depth reinforcements, welded to the top of end panels. Two 3/4" x 1-1/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle for supporting sinks.
- m. Support Struts: Support struts shall consist of two 16-gauge channel uprights fastened top and bottom by two adjustable 12 gauge "U" shaped spreaders, each, 1-1/2" x length required, formed from galvanized steel. Struts shall be furnished to support drain troughs, and to support worktop at plumbing space under fume hood superstructures or other heavy loads. Support struts can be furnished with hangers at extra cost when specified, to support mechanical service piping and drain lines.

2.5 CONSTRUCTION

A. General:

- 1. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project.
- 2. All cabinet bodies shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior corners shall be spot welded with heavy back up reinforcements.
- 3. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
- 4. Case openings of Inset style cabinets shall be rabbeted on all four sides for both hinged and sliding doors to provide a dust resistant case.
- 5. All cabinets shall have a cleanable smooth interior. Bottoms shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges.
- 6. Cabinets shall be designed using a standardized grid pattern to allow reconfiguration of doors and drawers.

B. Steel Gauges: Gauges of steel used in construction of cases shall be 18 gauge, except as follows:

1. Leveling bolt reinforcements 12 gauge.
2. Top and intermediate front horizontal rails, apron rails, hinge reinforcements, and reinforcement gussets, 16 gauge.
3. Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 20 gauge.

C. Base Cabinets:

1. End uprights shall be formed into not less than an L formation at top, bottom, back and a 3/4" wide front C formation. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for the support of drawer channels, intermediate rails, hinge screws, and shelf adjustment holes.
2. A 7/8" high top horizontal rail shall interlock with the flange at top of end panels for strength, but shall be flush at face of unit. Top rails not flush with face of end uprights are not acceptable.
3. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. Intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
4. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers.
5. Cabinet bottom shall be formed of one piece of steel, except in corner units, and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels. Front edge shall include a C formation to form a 7/8" high bottom front rail and shall be flush with face of end uprights. Cabinet bottom front rails not flush with face of end uprights are not acceptable.
6. Toe space rail shall extend up and forward to engage bottom panel to form a smooth surfaced fully enclosed toe space, 3" deep x 4" high.
7. Back construction shall be one piece with integral channel formed for maximum strength and welded to back of top and bottom flanges of end uprights.
8. Each bottom corner of base cabinets shall have a 3/8"-16 leveling bolt, 2-1/2" long capable of supporting 500 lbs. Access to the leveling bolts shall be through plug buttons in the cabinet bottom. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.
9. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear and formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
10. Steel Door assembly (two-piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material. Door assemblies shall be painted prior to assembly and shall be punched for attaching pulls. Inner pan formation of door shall be indented for in-field installation of locks when required.

11. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.
12. Drawer Assemblies: Drawer bodies shall be made in one-piece construction including the bottom, two sides, back and front. They shall be fully covered at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 3/4" thick drawer head.
13. Knee space panels, where shown or specified, shall be 20 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.

D. Special Purpose Storage Cabinets:

1. Acid Storage Fume Hood Cabinets: Acid storage fume hood cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be completely lined with a one-piece polyethylene corrosion resistant liner. The liner shall be 1/4" thick, molded into a seamless tub, including top, sides and bottom, with a 1" lip at the bottom front to contain spills. Tubs shall include integral cleats at both ends and back to support an optional shelf. Each door shall have a set of louvers at the top and bottom and have a 1/8" sheet polyethylene liner. Where specified, each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe allowing a positive airflow directly into the fume hood exhaust system. When specified or shown on drawings, cabinet shall include a full-depth phenolic resin.
2. Solvent Storage Cabinets: Solvent storage cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UFC, OSHA and NFPA No. 30 - 1993, and cabinets shall be FM approved and labeled. The bottoms, top, sides and doors shall be fabricated of 18-gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless-steel piano hinges and shall be fully insulated. The doors are self-closing and synchronized so that both doors will always fully close. The right-hand door is equipped with a three-point latching system that automatically engages when the doors close. Each door is equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A second pan shall be provided to serve as a full-depth adjustable shelf. Two, 2" diameter, diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw. The cabinet shall have interior finish same as exterior. The cabinet shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".
3. Vacuum Pump Cabinets: Vacuum pump cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be provided without a bottom to allow vacuum pumps and other equipment to be rolled in and out of the cabinet. The interior of the cabinet shall be lined with a 1 inch thick neoprene foam for sound deadening and easy cleaning. Each cabinet

shall be furnished with a 120 VAC, 20-amp, duplex receptacle mounted on the inside cabinet back and a pilot lighted toggle switch mounted in the top front panel. Each cabinet shall be furnished with a 1½" diameter PVC vent pipe in the back for venting or access to the fume hood above. The toe kick shall be attached to the doors and shall allow total access to the front of the cabinet. Internal wiring from the switch and pilot light to the receptacle shall not be furnished unless otherwise specified.

E. Upper Cabinet Construction:

1. Upper cabinets shall have a completely finished interior same as exterior and shall be designed so that no mounting hardware is visible when installed.
2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front edge of end upright shall be ¾" wide. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for hinge screws, and shelf adjustment holes.
3. Cabinet tops shall be formed with a 7/8" high C formation at the front edge and turned down at the back to engage a wall hanging rail.
4. Cabinet flush bottoms shall be formed with a 7/8" high C formation at the front edge.
5. Cabinet false bottoms shall be formed down on all four edges and shall be removable.
6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes. Holes shall be enclosed by end uprights.
7. Adjustable shelves shall be formed down ¾", returned back 7/8" and up ¼" into a channel formation front and rear, formed down ¾" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
8. Glazed doors shall be ¾" thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18-gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18-gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Glass shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with 1/8" tempered glass.
9. Solid panel doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be ¾" thick and contains sound deadening material.
10. Sliding doors shall be suspended from the top in a roll formed steel track fastened to the cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.
11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

12. Plate glass doors shall operate on an extruded aluminum track at the bottom of the cabinet, and in an extruded aluminum channel at the top. The bottom of each glass door shall be furnished with a continuous aluminum shoe the full length of the door, which shall be equipped with two nylon rollers that operate on the extruded aluminum track. The aluminum shoes on the bottom of the plate glass doors shall be equipped with pulls for operation of the doors, and also to prevent bypassing of the doors. Plate glass doors shall close against rubber bumpers. Plate glass doors shall be: 1/8" tempered glass

F. Steel Full Height Cabinet Construction:

1. Full height storage cabinets shall have a completely finished interior same as exterior.
2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front fascia of upright shall be 1-1/4" wide with inside edge formed in a channel 1/2" x 3/8". A full height box reinforcement shall be fitted to the channel, formed to provide a recessed strike for door and to reinforce the cabinet. The backside of the reinforcement shall be perforated with shelf adjustment holes spaced at not more than 1" centers. Back of upright shall be formed in a 2-1/2" formation. 16-gauge hinge reinforcement shall be welded to inner side of front uprights.
3. Cabinet tops shall be formed into a channel shape at front with flange at rear and sides for electro-welding cabinet top to cabinet back and ends. Front fascia channel shall be strengthened with electro-weld reinforcements.
4. Cabinet bottoms for storage cabinets shall be formed down on sides and back to create a square edge transition welded to cabinet end panels, and front edge shall be offset to create a seamless door recess rabbet for dust stop. Cabinet bottoms shall be formed to provide a flush 1" face rail with a return flange to give a 9/16" deep x 5" high toe space. All cabinets shall have a cleanable smooth interior.
5. Toe space rails shall interlock in back of bottom rail and with end panel to provide a welding plate and shall extend to the floor with a flange turned back and up for support.
6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes on not more than 1" centers. Holes shall be enclosed by a formation in cabinet back and enclosed by end uprights.
7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear; formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation electro-welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
8. Glazed doors shall be 3/4" thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18-gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18-gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Door glazing shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with 1/8" tempered glass
9. Solid panel doors shall consist of inner and outer pan formations mechanically assembled after painting. All full height solid panel doors shall be further

reinforced by a full-height channel formation welded to inner pan. Doors shall be 3/4" thick and contain sound deadening material.

10. Sliding doors shall be suspended from the top in a roll formed steel track welded to cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.
11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

G. Apron and Leg Assembly Construction:

1. In general, freestanding tables and/or apron and leg assemblies consist of welded leg assemblies connected to aprons by mechanical fasteners.
2. Table apron rails shall be formed of 16-gauge steel. The rails shall be 4" high, formed top and bottom into a channel formation. Where drawers occur, the apron rails shall provide the required opening.
3. Table legs shall be 2" square welded tubing. Securely welded to bottom end shall be a 14-gauge die formed gusset with four flanges. A threaded clinch nut shall accommodate a 3/8" 16 x 2-1/2" long leveling bolt. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling bolts. Use of leg shoe which does not conceal leveling device will not be acceptable.
4. Stretchers shall be constructed of 18-gauge steel and furnished where indicated on drawings. They shall be formed into a 2-7/64" x 1-1/2" channel formation, and secured to table legs by a die-formed clip of 16-gauge steel. Clips shall be welded at ends of channel.

2.6 PERFORMAMNCE REQUIREMENTS

A. Steel Casework Construction Performance:

1. Base cabinets shall be constructed to support at least a uniformly distributed load 200 pounds per square foot of cabinet top area, including working surface without objectionable distortion or interference with door and drawer operation.
2. Base cabinet leveling bolts shall support 500 pounds per corner, at 1-1/2" projection of the leveling bolt below the cabinet bottom.
3. Each adjustable and fixed shelf 4 feet or shorter in length shall support an evenly distributed load of 40 pounds per square foot up to a maximum of 200 pounds, with nominal temporary deflection, but without permanent.
4. Full extension soft-close, self-closing ball bearing zinc plated drawer slide shall be rated for 100-pound loads.
5. Swinging doors on floor-mounted inset style casework shall support 200 pounds suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.

B. Steel Paint System Finish and Performance Specification:

1. Steel Paint System Finish: After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline

cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals. After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance. The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.

2. Performance Test Results (Chemical Spot Tests):

a. Testing Procedure: Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of $77^{\circ} \pm 3^{\circ}$ F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

b. Test Evaluation: Evaluation shall be based on the following rating system.

1. Level 0 - No detectable change.
 2. Level 1 - Slight change in color or gloss.
 3. Level 2 - Slight surface etching or severe staining.
 4. Level 3 - Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.
- After testing, panel shall show no more than three (3) Level 3 conditions.

c. Test Reagents - Test No. Chemical Reagent Test Method

1. Acetate, Amyl Cotton ball & bottle
2. Acetate, Ethyl Cotton ball & bottle
3. Acetic Acid, 98% Watch glass
4. Acetone Cotton ball & bottle
5. Acid Dichromate, 5% Watch glass
6. Alcohol, Butyl Cotton ball & bottle
7. Alcohol, Ethyl Cotton ball & bottle
8. Alcohol, Methyl Cotton ball & bottle

9. Ammonium Hydroxide, 28% Watch glass Benzene Cotton ball & bottle
10. Carbon Tetrachloride Cotton ball & bottle
11. Chloroform Cotton ball & bottle
12. Chromic Acid, 60% Watch glass
13. Cresol Cotton ball & bottle
14. Dichlor Acetic Acid Cotton ball & bottle
15. Dimethylformamide Cotton ball & bottle
16. Dioxane Cotton ball & bottle
17. Ethyl Ether Cotton ball & bottle
18. Formaldehyde, 37% Cotton ball & bottle
19. Formic Acid, 90% Watch glass
20. Furfural Cotton ball & bottle
21. Gasoline Cotton ball & bottle
22. Hydrochloric Acid, 37% Watch glass
23. Hydrofluoric Acid, 48% Watch glass
24. Hydrogen Peroxide, 3% Watch glass
25. Iodine, Tincture of Watch glass
26. Methyl Ethyl Ketone Cotton ball & bottle
27. Methylene Chloride Cotton ball & bottle
28. Mono Chlorobenzene Cotton ball & bottle
29. Naphthalene Cotton ball & bottle
30. Nitric Acid, 20% Watch glass
31. Nitric Acid, 30% Watch glass
32. Nitric Acid, 70% Watch glass
33. Phenol, 90% Cotton ball & bottle
34. Phosphoric Acid, 85% Watch glass
35. Silver Nitrate, Saturated Watch glass
36. Sodium Hydroxide, 10% Watch glass
37. Sodium Hydroxide, 20% Watch glass
38. Sodium Hydroxide, 40% Watch glass
39. Sodium Hydroxide, Flake Watch glass
40. Sodium Sulfide, Saturated Watch glass
41. Sulfuric Acid, 33% Watch glass
42. Sulfuric Acid, 77% Watch glass
43. Sulfuric Acid, 96% Watch glass
44. Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts Watch glass
45. Toluene Cotton ball & bottle
46. Trichloroethylene Cotton ball & bottle
47. Xylene Cotton ball & bottle
48. Zinc Chloride, Saturated Watch glass

*Where concentrations are indicated, percentages are by weight.

3. Performance Test Results (Heat Resistance): Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

4. Performance Test Results (Impact Resistance): A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.
5. Performance Test Results (Bending Test): An 18-gauge steel strip, finished as specified, when bent 180° over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.
6. Performance Test Results (Adhesion): Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".
7. Performance Test Results (Hardness):
The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).
The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one, that is, the hardest pencil that will not rupture the film, is then used to express or designate the hardness.

2.7 WORKSURFACES

- A. Epoxy Resin Tops (Kemresin): Color to be: TBD
Epoxy Resin tops shall consist of modified epoxy resin that has been especially compounded and cured to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness, and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops and curbs shall be non-glaring. Tops shall be 1" thick, exposed edges beveled top and bottom, and drip grooves provided on the underside at all exposed edges. 4" high curbs at the backs and ends of tops shall be 1" thick and bonded to the deck to form a square watertight joint. Sink cutouts shall be smooth and uniform without saw marks with the top edge beveled. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radiused not less than 3/4"
- B. WORK TOP PERFORMANCE REQUIREMENTS:
 1. Molded Epoxy Resin (Kemresin):
 - a. Physical Properties:
Flexural Strength (A.S.T.M. Method D790-90) = 15,000
PSI Compressive Strength (A.S.T.M. Method D695-90) = 30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) = 100

Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours = 0.04

% by weight, 7 Days = 0.05

% by weight, 2 Hour Boil =

0.04 Specific Gravity = 1.97

Tensile Strength = 8,500 PSI

b. Performance Test Results (Heat Resistance):

A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

c. Performance Test Results (Chemical Resistance):

Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77o F.).

*Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial - Iso-Octane

Acetic Acid, 5% - Kerosene

Acetone - Methyl Alcohol

Ammonium Hydroxide, 28% - Mineral Oil

Ammonium Hydroxide, 10% - Methyl Ethyl Ketone

Aniline Oil - Nitric Acid, 70%**

Benzene - Nitric Acid, 40%

Carbon Tetrachloride - Nitric Acid, 10%

Chromic Acid, 40%** - Oleic Acid

Citric Acid, 10% - Olive Oil

Cottonseed Oil - Phenol, 5%

Dichromate Cleaning Solution** - Soap Solution, 1%

Diethyl Ether - Sodium Carbonate, 20%

Dimethyl Formamide - Sodium Carbonate, 2%

Distilled Water - Sodium Chloride, 10%

Detergent Solution, 1/4% - Sodium Hydroxide, 50%

Ethyl Acetate - Sodium Hydroxide, 10%

Ethyl Alcohol, 95% - Sodium Hydroxide, 1%

Ethyl Alcohol, 50% - Sodium Hypochlorite, 5%

Ethylene Dichloride - Sulfuric Acid, 85%

Heptane - Sulfuric Acid, 30%

Hydrochloric Acid, 37% - Sulfuric Acid, 3%

Hydrochloric Acid, 10% - Toluene

Hydrogen Peroxide, 28% - Transformer Oil

Hydrogen Peroxide, 3% - Turpentine

NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

d. Performance Test Results (Chemical Spot Tests - 24 Hours):

Chemical spot tests shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass,

convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

Ratings:

A = No effect or slight change in gloss.

B = Slight change in color or marked loss of gloss. C = Slight surface etching or severe staining.

D = Swelling, pitting, or severe etching.

Reagents* - Rating Acetic Acid, 98% - A Acetone** - A

Ammonium Hydroxide, 28% - A Carbon Tetrachloride** - A

Chloroform** - A

Chromic Acid, 60% - C Chromic Acid, 40% - C

Dichromate Cleaning Solution*** - C Dimethyl Formamide - A

Ethyl Acetate** - A Ethyl Alcohol** - A Formaldehyde, 37% - A

Formic Acid, 90% - A

Hydrochloric Acid, 37% - A Hydrofluoric Acid, 48% - C Hydrogen

Peroxide, 28% - A Methanol** - A

Methylethyl Ketone** - A Nitric Acid, 70% - B Phenol, 85% - A

Phosphoric Acid, 85% - A

Sodium Carbonate, 20% - A Sodium Hydroxide, 40% - A Sodium

Hydroxide, 10% - A Sodium Hypochlorite, 5% - A Sulfuric Acid, 96% -

D Sulfuric Acid, 85% - A Toluene** - A

Wrights Blood Stain - A Xylene** - A

* Where concentrations are indicated, percentages are by weight.

** Indicates these solvents tested with cotton and jar method.

*** Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

Stainless steel tops and working surfaces shall be Type 304 stainless steel unless otherwise specified. All exposed surfaces shall be 16 gauge stainless steel reinforced on the underside by 16 gauge carbon steel channels, so spaced as to prevent twisting, oil-canning or buckling. Exposed edges of tops shall be formed into a 1" thick channel shape, and suitable wood inserts shall be provided on all four edges of underside of top to facilitate anchoring to base units. Splash rails and curbs shall be formed from the same sheet as the top or so welded thereto that they form integral parts thereof. Top edges of curbs and splash-backs shall be formed into a channel shape. Unless otherwise shown or called for, all tops having built-in sinks shall have a raised rim 1" wide on all edges. Where stainless steel sinks are supplied, the sink bowl shall be so welded to the top as to form an integral part thereof. All welds shall be ground smooth and polished to a uniform satin finish over the entire top and sink assembly. Soldering of the sinks, curbs or

splash rails to the top will not be permitted. Mechanical joints or field joints, where made necessary by size, shall be a tight butt joint of the top surfaces, reinforced and held in alignment with steel reinforcements. After fabrication and polishing, surfaces of the tops shall be given a strippable plastic coating to protect the tops during shipment and installation. Underside of tops and sinks shall be coated with a plastic sound deadener.

C. SINKS AND DRAINS

1. Materials: Molded Epoxy Resin Undermount Sinks (KEMRESIN):
 - a. Sinks shall be molded of modified epoxy resin, carefully compounded with selected materials to provide maximum physical and chemical properties. Sinks shall be non-glaring with all inside corners coved and the bottom pitched to the drain outlet. Sinks shall possess a high resistance to mechanical and thermal shock.

D. FITTINGS

1. Materials:
 - a. Laboratory Service Fittings: Service fittings shall be laboratory grade, and water faucets and valve bodies shall be cast red brass alloy or bronze forgings, with a minimum content of 85%. All fittings shall be chromium plated unless specified otherwise.
 - b. Plastic Coated Finish: When specified, laboratory service fittings shall have an acid resistant plastic coating applied over a fine sand-blasted surface. Surfaces shall be sprayed and baked three times with a minimum thickness of .0005 to .0010 mils. (See Performance Ratings).
 - c. Service Indexes: Fittings shall be identified with service indexes in the following color coding:
 1. Hot Water – Red
 2. Cold Water - Dark Green
 3. Gas - Dark Blue
 4. Air – Orange
 5. Vacuum – Yellow
 6. Distilled Water - White
 7. Steam - Black
 8. Nitrogen - Brown
 9. Oxygen - Light Green
 10. Hydrogen – Pink
 11. Special Gases - Light Blue
2. CONSTRUCTION:
 - a. Water Fittings: Water fittings shall be provided with a renewable unit containing all operating parts which are subject to wear. The renewable unit shall contain an integral volume control device and all faucets shall be capable of being readily converted from compression to self-closing, without disturbing the faucet body proper. Four (4) arm forged brass handles shall contain plastic screw-on type colored service index buttons.
 - b. Steam Fittings: Steam fittings shall have a black, heat resistant composition handle, and shall be the heavy pattern design with stainless steel removable seat and flat Teflon seat disc. They shall have Teflon

- impregnated packing and shall be so constructed that they can be repacked under pressure.
- c. Distilled Water Fittings: Distilled water fittings shall be chromium plated cast bronze with the interior tin lined, and shall be the self-closing type, or shall be made of aluminum and not be the self-closing type. Handles shall be furnished with tamper-proof and vandal resistant service indexes.
 - d. Laboratory Ball Valves: Laboratory ball valves shall have a forged brass valve body with a non-removable serrated hose end and a forged brass lever-type handle with a full view color-coded index button. Valves shall have a floating chrome plated brass ball and molded TFE seals. Valves shall be certified by CSA International for use with natural gas under ANSI Z21.15./CGA9.1
 - e. Needle Valve Hose Cocks: Needle type valves shall have a stainless steel replaceable floating cone, precision finished and self-centering. Cone locates against a stainless-steel seat, easily removable and replaced with a socket wrench. Valve shall have "TEFLON" impregnated packing and designed so unit can be repacked while under pressure.
 - f. Gooseneck Type Outlets: Gooseneck outlets shall have a separate brazed coupling to provide a full thread attachment of anti-splash, serrated tip or filter pump fittings.
 - g. Remote Control Valves: All valves for remote control use shall be as previously specified, but shall be complete with aluminum extension rods, escutcheon plates, brass forged handles and screw-on type colored service index button.
 - h. Tank Nipples: Tank nipples shall be provided with locking nut and washer for all fixtures where fittings are anchored to equipment.
 - i. Sink Outlets: Unless otherwise specified, sink outlets for other than stainless steel sinks shall be sin, with integral cross bars, tapered for overflow and be complete with gasket and lock nut with 1-1/2" I.P.S. male straight thread outlet. Overflows shall not be furnished for sink outlets unless specifically called for.
 - j. Crumb Cup Strainers: Crumb cup strainers shall be stainless steel or chromium plated brass, as specified, and shall be furnished for stainless steel sinks, and be complete with gasket, lock nut and 4" long unthreaded tailpiece outlet in 1-1/2" size.
 - k. Vacuum Breakers: Vacuum breakers where required shall be "Nidel" or "Watts" unless otherwise specified or identified to be an integral part of the water fixture assembly.
 - l. Aerator Outlets: Aerator type outlets shall be furnished for all gooseneck water faucets not furnished with serrated hose connectors.
 - m. Waste Lines: Waste lines shall be furnished by other trades.
 - n. Traps: Traps shall be furnished by other trades.
 - o. Electrical Fittings: Electrical fittings shall contain 20 Amp., 125 Volt AC, 3-wire polarized grounded receptacles, unless otherwise specified. Pedestal and line-type boxes shall be of aluminum, metallic finish with stainless steel flush plates. Receptacle boxes shall be of plated steel. All electrical or conduit fittings called for or to be furnished under these

specifications shall meet the requirements of the National Electrical Code.

3. PERFORMANCE:

- a. Maximum Line Pressures:
Laboratory Ball Valves (Gas and Air) - 75 PSI
Needle Point Cocks (Gas and Air) - 65 PSI
Vacuum - 28.5" Mercury
Hot and Cold Water - 80 PSI
Steam - 30 PSI
- b. Finish Performance:
Finish shall show no rupture, other than a slight discoloration or possible softening when subjected to the following fumes for approximately six (6) days: Plastic coated fittings shall be suspended in a container, 6 cu. ft. capacity 12" above open beakers, each containing 199 cc. of 70% Nitric Acid, 94% Sulphuric Acid, 37-38% Hydrochloric Acid, respectively. Finish shall also withstand direct contact of reagents dropped from a burette at a rate of 60 drops/min. for a period of 10 minutes. Chemicals are shown below:

Concentrated Hydrochloric Acid 37-38%*
Concentrated Nitric Acid 70%*
Concentrated Sulphuric Acid 94%
Glacial Acetic Acid 99.5%
Ethyl and Other Alcohols
Toulene and Other Hydrocarbons
Carbon – Tetrachloride
Mineral Oil

*Percentages are by weight.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

3.2 INSTALLATION

- A. Preparation: Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.
- B. Coordination: Coordinate the work of the Section with the schedule and other requirements of other work being prepared in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

- C. Performance:
1. Casework:
 - a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
 - b. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
 - c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
 - d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8".
 2. Worksurfaces:
 - a. Where required due to field conditions, scribe to abutting surfaces.
 - b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
 - c. Secure worksurfaces to casework and equipment components with materials and procedures recommended by the manufacturer.
 - d. Adjust and Clean:
 1. Repair or remove and replace defective work, as directed by owner and/or representative upon completion of installation.
 2. Adjust doors, drawers and other moving or operating parts to function smoothly.
 3. Clean shop finished casework; touch up as required.
 4. Clean worksurfaces and leave them free of all grease and streaks.
 5. Casework to be left broom clean and orderly.
 3. Protection:
 - a. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
 - b. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

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SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Specialty valves.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 5. Manual control stations.
 - 6. Control panels.
 - 7. Pressure gages.
- B. Related Requirements:
 - 1. Section 283111 "Digital, Addressable Fire-Alarm System" for fire alarm devices interfacing with fire sprinkler systems.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and professional engineer.

- B. Design Data:
 - 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- C. Welding certificates.
- D. Field Test Reports:
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - 2. Fire-hydrant flow test report.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of sprinkler service.

2. Do not proceed with interruption of sprinkler service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the NFPA 13, 2013 Edition.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 1. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Refer to plans for Sprinkler Occupancy Hazard Classifications:
 2. Refer to plans for Minimum Density for Automatic-Sprinkler Piping Design:
 3. Refer to plans for Maximum Protection Area per Sprinkler:

2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40, Black-Steel Pipe: ASTM A53/A53M, Type E, Grade A. Pipe ends may be factory or field threaded or roll-grooved to match joining method.
- B. Black-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- C. Uncoated-Steel Couplings: ASTM A865/A865M, threaded.
- D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Tyco Fire & Building Products LP.

- d. Victaulic Company.
2. Pressure Rating: 250-psig minimum.
3. Uncoated Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 1. Valves shall be UL listed or FM approved
 2. Minimum Pressure Rating for High-Pressure Piping: 250 psig.
- B. Ball Valves:
 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 2. Standard: UL 1091.
 3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 5. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Iron Butterfly Valves:
 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corp.
 2. Standard: UL 1091
 3. Body Material: Cast or ductile iron.
 4. Style: Lug or wafer.
 5. End Connections: Grooved.
- D. Check Valves:
 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Roemer.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corp.
 2. Standard: UL 312.
 3. Pressure Rating: 250 psig minimum.

4. Type: Swing check.
 5. Body Material: Cast iron.
 6. End Connections: Flanged or grooved.
- E. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. NIBCO INC.
 - b. United Brass Works, Inc.
 2. Standard: UL 262.
 3. Pressure Rating: 250 psig minimum.
 4. Body Material: Bronze.
 5. End Connections: Threaded.
 6. Control Valves should be capable of being locked in the open position in addition to being electronically supervised.
- F. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. NIBCO INC.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire & Building Products LP.
 2. Standard: UL 262.
 3. Pressure Rating: 250 psig minimum.
 4. Body Material: Cast or ductile iron.
 5. End Connections: Flanged or grooved.
 6. Control Valves should be capable of being locked in the open position in addition to being electronically supervised.
- G. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Global Safety Products, Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 250 psig minimum.
 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 6. Valve Operation: Integral electrical, 115-V AC, prewired, single-circuit, supervisory switch visual indicating device.

7. Control Valves should be capable of being locked in the open position in addition to being electronically supervised.

H. NRS Gate Valves:

1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Clow Valve Company; a division of McWane, Inc.
 - b. NIBCO INC.
 - c. Tyco Fire & Building Products LP.
 - d. Standard: UL 262.
 - e. Pressure Rating: 250 psig minimum.
 - f. Body Material: Cast iron with indicator post flange.
 - g. Stem: Non-rising.
 - h. End Connections: Flanged or grooved.
 - i. Control Valves should be capable of being locked in the open position in addition to being electronically supervised.

2.4 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing and "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Fire Protection Products, Inc.
 - c. Potter Roemer.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.

D. Globe Valves:

1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.

2.5 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 - 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Globe Fire Sprinkler Corp.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corp.
 - 2. Standard: UL 193.
 - 3. Design: For horizontal or vertical installation.
 - 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
 - 5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 - 6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Automatic (Ball Drip) Drain Valves:
 - 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - 2. Standard: UL 1726.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Type: Automatic draining, ball check.
 - 5. Size: NPS 3/4.
 - 6. End Connections: Threaded.

2.6 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Standard: UL 213.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 5. Type: Mechanical-tee and -cross fittings.
 - 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Flow Detection and Test Assemblies:
- 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded or grooved.
- C. Sprinkler Inspector's Test Fittings:
- 1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGF Manufacturing Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Cast- or ductile-iron housing with sight glass.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Globe Fire Sprinkler Corporation.
 - 2. Reliable Automatic Sprinkler Co., Inc.
 - 3. Tyco Fire & Building Products LP.

4. Victaulic Company.
 5. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199
 2. Characteristics: Nominal 17/32-inch (12.7-mm) orifice with Discharge Coefficient K of 8.0, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 199.
 3. Type: Wire cage with fastening device for attaching to sprinkler.

2.8 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 753.
 3. Type: Mechanically operated, with Pelton wheel.
 4. Alarm Gong: Cast aluminum with red-enamel factory finish.
 5. Size: 8-1/2-inches diameter.
 6. Components: Shaft length, bearings, and sleeve to suit wall construction.
 7. Inlet: NPS 3/4.
 8. Outlet: NPS 1 drain connection.
- C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.

2. Standard: UL 464.
 3. Type: Vibrating, metal alarm bell.
 4. Size: 10-inch diameter.
 5. Finish: Red-enamel factory finish, suitable for outdoor use.
 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 - c. Viking Corporation.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig.
 7. Design Installation: Horizontal or vertical.
- E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 - c. Tyco Fire & Building Products LP.
 - d. Viking Corporation.
 2. Standard: UL 346.
 3. Type: Electrically supervised water-flow switch with retard feature.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design Operation: Rising pressure signals water flow.
- F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled valve is in other than fully open position.

6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.9 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements of this specification, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 WATER-SUPPLY CONNECTIONS

- A. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install sleeve seals for piping penetrations of concrete walls and slabs.
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:
 - 1. Schedule 40, black-steel pipe with threaded or grooved ends; uncoated, gray-iron threaded or grooved fittings; and threaded or grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded or grooved ends; uncoated, gray-iron threaded or grooved fittings; and threaded or grooved joints.
2. Schedule 10, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 3. Wall Mounting: Sidewall sprinklers.

END OF SECTION

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SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
1. Motors 1/20 HP and Smaller: Shaded-pole type.

- D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

END OF SECTION

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SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop collar.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded water stop collar.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - 2. Zurn Industries, LLC.

- B. Description: Manufactured, Dura-coated or Duco coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
- B. Description:
 - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 2. Designed to form a hydrostatic seal of 20 psig minimum.
 - 3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Carbon steel.
 - 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
- B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall.
- C. Plastic or rubber water stop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

- A. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. May National Associates, Inc.; a subsidiary of Sika Corporation.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078400 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade:

- a. Piping Smaller Than NPS 6: Steel pipe sleeves.
- b. Piping NPS 6 and Larger: Steel pipe sleeves
- 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6 Steel pipe sleeves with sleeve-seal system
 - b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

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SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Mid-America Fittings, Inc.
 - 3. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls and ceilings.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:

- a. Chrome-Plated Piping: One-piece cast brass or split-casting brass with polished, chrome-plated finish.
- b. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- f. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gages.
 - 5. Gage attachments.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Certificates: For each type of meter and gage.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Ashcroft Inc.
 - 2. Weksler Glass Thermometer Corp.
 - 3. WIKA Instrument Corporation.
- B. Standard: ASME B40.200.
- C. Case: Sealed] type(s); stainless steel with 3-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus, or minus 1 percent of scale range.
- M. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Trerice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Weksler Glass Thermometer Corp.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass.
 - 8. Stem: Adjustable, brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR.
 - 4. Type: Stepped shank unless straight or tapered shank is indicated.
 - 5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - 6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - 7. Bore: Diameter required to match thermometer bulb or stem.
 - 8. Insertion Length: Length required to match thermometer bulb or stem.
 - 9. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.3 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.100.
 - 3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 - 8. Pointer: Dark-colored metal.
 - 9. Window: Glass or plastic.
 - 10. Ring: Metal.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- E. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- F. Install valve and snubber in piping for each pressure gage for fluids.
- G. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
- H. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.
- I. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- J. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - 1. Metal case, industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.4 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
- B. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 22 05 23.12

BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

- A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS SP-145.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE 150 PSIG OR LESS

- A. Pipe NPS 2 and Smaller:
 - 1. Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Brass ball valves, two-piece with full port and stainless-steel trim.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Brass ball valves, two-piece with full port and stainless-steel trim. Provide with threaded or solder-joint ends.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Steel ball valves, Class 150 with full port.
 - 3. Iron ball valves, Class 150.

END OF SECTION

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SECTION 22 05 23.13

BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B16.5 for flanges on steel valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

4. ASME B31.9 for building service piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. WATTS.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

END OF SECTION

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SECTION 22 05 23.14

CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.9 for building services piping valves.

- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Bronze Disc, Class 150:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 - 1. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 150, with soldered or threaded end connections.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze swing check valves with bronze disc, Class 150, with soldered or threaded end connections.

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal hanger-shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe-positioning systems.
 - 8. Equipment supports.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
 - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 4. Channels: Continuous slotted carbon-steel channel with inturned lips.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 8. Metallic Coating: Hot dip galvanized.
 - 9. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 THERMAL HANGER-SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. National Pipe Hanger Corporation.
 - 2. Pipe Shields Inc.
 - 3. Piping Technology & Products, Inc.

- B. Insulation-Insert Material for Cold Piping ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Hilti, Inc.
 - c. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated steel.
 - 3. Outdoor Applications: Stainless steel.

2.7 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 MATERIALS

- A. Carbon Steel: ASTM A1011/A1011M.
- B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- C. Stainless Steel: ASTM A240/A240M.
- D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 4. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
 - 6. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Craftmark Pipe Markers.
 - c. LEM Products Inc.
 - 2. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: White.
 - 4. Background Color: Black.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Marking Services Inc.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Brady Corporation.
 - 2. Craftmark Pipe Markers.
 - 3. LEM Products Inc.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or beaded chain.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
1. Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 2. Domestic Water and Lab Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety black.
 - b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

- A. within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 2. Valve-Tag Colors:
 - a. Cold Water: Safety green.
 - b. Hot Water: Safety green.
 - c. Compressed Air: Safety blue.
 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.
 - c. Compressed Air: White.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Roof drains and rainwater leaders.
 - 5. Supplies and drains for handicap-accessible lavatories and sinks.
 - 6. Air Conditioning Coil Condensate Waste Piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.
 - 2. Preformed Pipe Insulation: Type I, Grade A, with factory applied ASJ.
 - 3. 850 deg F.
 - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ramco Insulation, Inc.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 3. Wet Flash Point: Below 0 deg F.
 - 4. Service Temperature Range: 40 to 200 deg F.
 - 5. Color: Black.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.

- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.

2.4 MASTICS AND COATINGS

- A. Vapor Retarder Mastic Water Based: Suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.
- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: 20 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Pittsburgh Corning Corporation.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 58 to plus 176 deg F.
 - 4. Color: White or gray.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Foster Brand; H. B. Fuller Construction Products.

b. Vimasco Corporation.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Knauf Insulation.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

- A. Bands:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
 2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015-inch thick, 1/2-inch wide with wing seal.
- B. Wire: 0.062-inch soft-annealed, stainless steel.

2.12 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Plumberex Specialty Products, Inc.
 - b. Truebro.
 - c. Zurn Industries, LLC.
 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
- B. Seal penetrations with flashing sealant.
- C. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- D. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

- E. Seal jacket to roof flashing with flashing sealant.
- F. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- G. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for fire-stopping and fire-resistive joint sealers.
- H. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

- Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2-inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.
 - B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
 - C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.
 - D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.
 - E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2-inch thick.
 - G. Air Conditioning Coil Condensate Drain: Mineral fiber, preformed pipe insulation 1/2-inch thick ASJ-SSI, with fitting covers or Flexible Elastomeric 1/2-inch thick.
- 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - 1. None.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1.3 ACTION SUBMITTALS

- A. Product Data:

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L (ASTM B88M, Type B).
- B. Annealed-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A).
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Wrought Copper Unions: ASME B16.22.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8-inch thick or ASME B16.21, non-metallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

2.5 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - b. Smith-Blair, Inc.
 - c. Viking Johnson.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. HART Industrial Unions, LLC.

- b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 150 psig.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. WATTS.
 - b. Wilkins.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 150 psig.
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Nonconducting materials for field assembly of companion flanges.
 - 3. Pressure Rating: 150 psig.
 - 4. Gasket: Neoprene or phenolic.
 - 5. Bolt Sleeves: Phenolic or polyethylene.
 - 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Elster Perfection Corporation.
 - b. Precision Plumbing Products.
 - c. Sioux Chief Manufacturing Company, Inc.
 - 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type A) wrought-copper, solder-joint fittings and brazed.
- D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast or wrought-copper, solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast or wrought-copper, solder-joint fittings; and soldered joints.

3.2 EARTHWORK

- A. Comply with requirements in Civil specifications for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- E. Install valves according to the following:
 - 1. Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
 - 3. Section 220523.14 "Check Valves for Plumbing Piping."
- F. Install domestic water piping level and plumb.
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- J. Install piping to permit valve servicing.
- K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- O. for thermostats in Section 221123 "Domestic Water Pumps."
- P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- D. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for copper tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper tubing and piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

- 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
- d. Repeat procedures if biological examination shows contamination.
- e. Submit water samples in sterile bottles to authorities having jurisdiction.

END OF SECTION

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Temperature-actuated, water mixing valves.
 - 5. Strainers for domestic water piping.
 - 6. Outlet boxes.
 - 7. Hose bibbs.
 - 8. Wall hydrants.
 - 9. Roof hydrants.
 - 10. Drain valves.
 - 11. Water-hammer arresters.
 - 12. Trap-seal primer device.
 - 13. Flexible connectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction,

and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 12 psig maximum, through middle third of flow range.
 - 5. Body: Bronze for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 7. Configuration: Designed for horizontal, straight-through flow.
 8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- B. Beverage-Dispensing-Equipment Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1022.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS 1/4 or NPS 3/8.
 5. Body: Stainless steel or non-metallic.
 6. End Connections: Threaded or flare.

2.5 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. NIBCO INC.
 - c. WATTS.
 2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
 3. Body: Brass or bronze.
 4. Size: Same as connected piping, but not larger than NPS 2.
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Leonard Valve Company.
 - c. WATTS.
 2. Standard: ASSE 1070.
 3. Pressure Rating: 125 psig.

4. Type: Thermostatically controlled, water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Valve Finish: Rough bronze.
- B. Primary, Electronic, Water Mixing Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 4. Type: Exposed, electronically controlled, water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded or solder joint inlets and outlet.
 7. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
 8. Tempered-Water Setting: 140 deg F.
 9. Valve Finish: Bronze.
 10. Digital temperature control and monitoring module.
 - a. Controls temperature within plus or minus 2 deg F.
 - b. User programmable at module or through BAS.
 - c. ASHRAE 188 compliance.
 - d. Local and remote monitoring.
 - e. Modbus protocol language(s).
 - f. 115 V ac, 60 Hz.
 - g. Battery backup.
- C. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Leonard Valve Company.
 - b. POWERS; A WATTS Brand.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 4. Material: Bronze body with corrosion-resistant interior components.
 5. Temperature Control: Adjustable.
 6. Connections: Threaded inlets and outlet.
 7. Finish: Chrome plated.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Keckley Company.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated for NPS 2-1/2 and larger.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4.
7. Drain: Pipe plug.

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Oatey.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Symmons Industries, Inc.
2. Mounting: Recessed.
3. Material and Finish: Plastic box and faceplate.
Faucet: Combination valved fitting or separate hot and cold water valved fittings complying with ASME A112.18.1 Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Drain Outlet Connection: NPS 2.
5. Accessory: Water hammer arresters.
6. Supply Shutoff Fittings: NPS ½ gate, globe, or ball valves and NPS ½ copper, water tubing.
7. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Ice maker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Guy Gray, IPS Corporation.
 - b. Oatey.
 - c. Water-Tite, IPS Corporation.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.

6. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Woodford Manufacturing Company.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle.
14. Operation for Finished Rooms: Wheel handle.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. WATTS.
 - b. Woodford Manufacturing Company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Rough bronze.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

2.11 ROOF HYDRANTS

- A. Non-freeze, Draining-Type Roof Hydrants:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. MIFAB, Inc.
 - b. Woodford Manufacturing Company.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.21.3M.
 - 3. Type: Non-freeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
 - 4. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
 - 5. Inlet: NPS 3/4.
 - 6. Outlet: Garden-hose thread complying with ASME B1.20.7.
 - 7. Vacuum Breaker:
 - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 - 2. Pressure Rating: 400-psig minimum CWP.
 - 3. Size: NPS 3/4.
 - 4. Body: Copper alloy.
 - 5. Ball: Chrome-plated brass.
 - 6. Seats and Seals: Replaceable.
 - 7. Handle: Vinyl-covered steel.
 - 8. Inlet: Threaded or solder joint.
 - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.13 WATER-HAMMER ARRESTERS

- A. Water-Hammer Arresters:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Precision Plumbing Products.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. WATTS.
 - 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 TRAP-SEAL PRIMER DEVICE

- A. Supply-Type, Trap-Seal Primer Device:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. Precision Plumbing Products.
 - c. WATTS.
 2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.15 FLEXIBLE CONNECTORS

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Flex-Hose Co., Inc.
 - b. Mason Industries, Inc.
 - c. Metraflex Company (The).
2. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.
3. Working-Pressure Rating: Minimum 200 psig.
4. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
5. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with airgap fitting, fixed airgap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- C. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

- D. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve and pump.
- E. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061053 "Rough Carpentry."
- F. Non-freeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.
- G. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- H. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated, water mixing valves.
 - 6. Outlet boxes.
 - 7. Wall hydrants.
 - 8. Roof hydrants.
 - 9. Trap-seal primer device.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addi-

tion to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections.
 - 1. Test each reduced-pressure-principle backflow preventer, and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 22 11 23.21

INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vertically mounted, in-line, close-coupled centrifugal pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which pumps will be attached.
 - 2. Size and location of initial access modules for acoustical tile.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Bell & Gossett; a Xylem brand.
 - 3. Grundfos Pumps Corp.
- C. Capacities and Characteristics:
 - 1. Capacity: Refer to schedule on plans.
 - 2. Total Dynamic Head: Refer to schedule on plans.
 - 3. Casing Material: Bronze.
 - 4. Impeller Material: ASTM B584, cast bronze or stainless steel.
 - 5. Minimum Operating Pressure: 175 psig.
 - 6. Maximum Continuous Operating Temperature: 225 deg F.
 - 7. Inlet and Outlet Size: Refer to schedule on plans
 - 8. Pump Control: Thermostat.
 - 9. Pump Speed: Refer to schedule on plans.
 - 10. Motor Horsepower: Refer to schedule on plans.
 - 11. Electrical Characteristics:
 - a. Volts: 120 V.
 - b. Phases: Single phase.
 - c. Hertz: 60 Hz.
 - d. Full-Load Amperes: 4.7> A.
- D. Pump Construction:
 - 1. Casing: Radially split bronze, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - 2. Impeller: Bronze or stainless steel, statically and dynamically balanced, closed, and keyed to shaft.
 - 3. Shaft and Shaft Sleeve: Steel or stainless-steel shaft, with copper-alloy shaft sleeve.

4. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
 5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 6. Bearings: Oil-lubricated; bronze-journal or ball type.
 7. Minimum Working Pressure: 175 psig.
 8. Continuous Operating Temperature: 225 deg F.
- E. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
 2. Range: 50 to 125 deg F.
 3. Enclosure: NEMA 250, Type 4X.
 4. Operation of Pump: On or off.
 5. Transformer: Provide if required.
 6. Power Requirement: 120 V ac.
 7. Settings: Start pump at 110 deg F and stop pump at 120 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
1. Comply with requirements for vibration isolation devices specified in Fabricate brackets or supports as required.
 2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

- D. Install thermostats in hot-water return piping.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Vertically mounted, in-line, close-coupled centrifugal pumps.
 - b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:
 - 1. Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Section 220523.14 "Check Valves for Plumbing Piping."
 - 3. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.
- C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.

- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set thermostats, for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.
 - 9. Adjust temperature settings on thermostats.
 - 10. Adjust timer settings.

3.8 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. Copper tube and fittings.
 - 4. PVC pipe and fittings.
 - 5. Specialty pipe fittings.
 - 6. Encasement for underground metal piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 74, Service class(es).
- C. Gaskets: ASTM C 564, rubber.
- D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 888 or CISPI 301.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.

- D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.7 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 4. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Apollo Flow Controls; Conbraco Industries, Inc.
 - 2) Dresser, Inc.
 - 3) Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
1. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Capitol Manufacturing Company.
 - 2) WATTS.
 - 3) Wilkins.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 2. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Capitol Manufacturing Company.
 - 2) WATTS.
 - 3) Wilkins.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 3. Dielectric-Flange Insulating Kits:

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Central Plastics Company.
 - 3) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
- 4. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Josam Company.
 - 2) Precision Plumbing Products.
 - 3) Victaulic Company.
 - b. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Civil specifications.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drainpipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal IW Waste Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install underground piping according to ASTM D 2321.
- Q. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- R. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- S. Install force mains at elevations indicated.
- T. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- G. Plastic, Non-Pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Shielded, non-pressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install hangers for cast-iron and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical runs of cast iron and copper soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.

- c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- C. Aboveground, vent piping NPS 4 and smaller shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- D. Aboveground, vent piping NPS 5 and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings; cast-iron hubless-piping couplings; and coupled joints.
- F. Underground, soil and waste piping NPS 5 and larger shall be the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
- G. Underground sanitary-sewage force mains NPS 4 shall be the following:
1. Hard copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Miscellaneous sanitary drainage piping specialties.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.36.2M.

3. Size: Same as connected drainage piping
 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Countersunk or raised-head brass plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Exposed Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing threaded, adjustable housing cleanout.
 3. Size: Same as connected branch.
 4. Type: Heavy-duty, adjustable housing.
 5. Body or Ferrule: Cast iron.
 6. Closure: Brass plug with tapered threads.
 7. Adjustable Housing Material: Cast iron with setscrews or other device.
 8. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 9. Frame and Cover Shape: Round.
 10. Top-Loading Classification: Heavy Duty.
 11. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to clean out.
- C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASME A112.36.2M. Include wall access.
 3. Size: Same as connected drainage piping.
 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure Plug:
 - a. Brass.
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
 6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.

- B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2and Larger: 5-inch-minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Floor-Drain, Inline Trap Seal:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co., a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Rector Seal Plumbing; A CSW Industrials Company.
 2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
 3. Material: Polymer.
 4. Standard: Tested and certified in accordance with ASSE 1072.
 5. Listing: ICC-ES or IAPMO listed.
 6. Size: Same as floor drain outlet or strainer throat.
- E. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- F. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- G. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- H. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- I. Expansion Joints:
 1. Standard: ASME A112.6.4.
 2. Body: Cast iron with bronze sleeve, packing, and gland.
 3. End Connections: Matching connected piping.
 4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping.
 1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Assemble open drain fittings and install with top of hub 2 inches above floor.
- F. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- J. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

- K. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- L. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- M. Install wood-blocking reinforcement for wall-mounting-type specialties.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 13 19.13

SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Floor sinks.
 - 3. Trench drains.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.3.
 - 3. Body Material: Gray iron.
 - 4. Seepage Flange: Required.
 - 5. Anchor Flange: Required.
 - 6. Outlet: Bottom.
 - 7. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 - 8. Top or Strainer Material: Nickel bronze Top Loading Classification: Light Duty.
 - 9. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 10. Trap Material: Cast iron.

11. Trap Pattern: Deep-seal P-trap.
12. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

- A. Cast-Iron Floor Sinks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
 2. Standard: ASME A112.6.7.
 3. Pattern: Floor drain.
 4. Body Material: Cast iron.
 5. Anchor Flange: Required, with seepage holes.
 6. Outlet: Bottom, connection.
 7. Coating on Interior Surfaces: Acid-resistant enamel.
 8. Internal Strainer: Dome.
 9. Internal Strainer Material: Aluminum.
 10. Top Grate Material: Cast iron, loose.
 11. Top Shape: Square.
 12. Dimensions of Top Grate: 12 x 12 inches.
 13. Top Loading Classification: No traffic.

2.4 TRENCH DRAINS

- A. Trench Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABT.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASME A112.6.3 for trench drains.
 3. Material: Ductile or gray iron.
 4. Flange: Anchor.
 5. Outlet: End.
 6. Grate Material: Ductile iron.
 7. Top Loading Classification: Heavy Duty.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.

- 3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 - 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Install open drain fittings with top of hub 2 inches above floor.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for oil interceptors
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 15 13

GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes piping and related specialties for general-service compressed-air systems:
 - 1. Pipes, tubes, and fittings.
 - 2. Joining materials.
 - 3. Valves.
 - 4. Dielectric fittings.
 - 5. Flexible pipe connectors.
 - 6. Specialties.
 - 7. Quick couplings.
 - 8. Hose assemblies.
 - 9. Hose Reels
- B. Related Sections include the following:
 - 1. Section 221519 "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Flexible pipe connectors.
 - 3. Safety valves.
 - 4. Pressure regulators. Include rated capacities and operating characteristics.
 - 5. Automatic drain valves.
 - 6. Filters. Include rated capacities and operating characteristics.
 - 7. Lubricators. Include rated capacities and operating characteristics.
 - 8. Quick couplings.
 - 9. Hose assemblies.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
 - 2. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.
 - 3. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by manufacturers.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. ASME Compliance:
 - 1. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
 - 1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
 - 3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
 - 4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
 - 5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
 - 6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
 - 7. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.
- B. Copper Tube: ASTM B88, Type K or L (ASTM B88M, Type A or B) and ASTM B88, Type M (ASTM B88M, Type C) seamless, drawn-temper, water tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123.
 - 4. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Apollo Flow Controls; Conbraco Industries, Inc.
 - 2) Elkhart Products Corporation.
 - 3) Viega LLC.
 - C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
 - D. Aluminum Piping System: Aluminum pipe, Alloy Grade AA 6035-T5, for push-connect bite ring couplings, and roll-groove couplings.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Gardner Denver, Inc.
 - b. Ingersoll-Rand.
 - c. SynergAir.
 - 2. Source Limitations: Obtain aluminum piping systems and components from single source from single manufacturer.
 - 3. Pressure and Temperature Range: Aluminum piping and related specialties for general-service compressed-air systems operating at 220 psig or less, across a temperature range of minus 4 to plus 176 deg F.
 - 4. Tubing, 14 to 273 mm: Aluminum pipe, Alloy Grade AA 6063-T5.
 - 5. Pipe Coating: Powder-coated paint certified nontoxic to AAMA 603 and AAMA 605, blue for compressed air.
 - 6. Tubing shall be quality controlled to comply with tolerances specified by roll-groove or push-to-connect coupling manufacturer. Tubing manufacturer shall follow ISO 9001:2000 quality standards.
 - 7. Pipe Identification: Decal with maximum working pressure and temperature on each length of pipe.
 - 8. Push-Connect Bite Ring Couplings, 14 to 63 mm: Solid-brass and nickel-plated body, high nitrile rubber O-ring seal in excess of 36 percent, and AISI Type 304 stainless-steel clamping washer.
 - 9. Fittings: Solid brass and nickel plated.
 - 10. Ball Valves, 20 to 63 mm: NPT threaded ends, or push-connect bite ring ends.

2.2 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 VALVES

- A. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Capitol Manufacturing Company.
 - b. Viega LLC.
 - c. WATTS.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Viega LLC.
 - b. WATTS.
 - c. Wilkins.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 psig.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.

- c. Pipeline Seal and Insulator, Inc.
- 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.5 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Metraflex Company (The).
- B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
 - 3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 SPECIALTIES

- A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
 - 1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
- B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
 - 1. Type: Pilot operated.
- C. Air-Line Pressure Regulators: Diaphragm operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
- D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.

- E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.
- F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.
- G. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated.
 - 1. Provide with automatic feed device for supplying oil to lubricator.

2.7 QUICK COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Aeroquip Corporation.
 - 2. Milton Industries, Inc.
 - 3. Parker Hannifin Corp.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Flow-sensor-bleeder, check-valve type with barbed outlet for attaching hose.
- D. Valve less Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 - 2. Plug End: With barbed outlet for attaching hose.

2.8 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
 - 1. Hose: Reinforced single-wire-braid, CR-covered hose for compressed-air service.
 - 2. Hose Clamps: Stainless-steel clamps or bands.
 - 3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
 - 4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.9 HOSE REELS:

- A. Basis of Design: Subject to compliance with requirements, the basis of design is Reelcraft's Series 5635 OLPTW Premium-Duty, Spring-Retractable, General-Purpose Hose Reel complete with 35 feet of 3/8" ID hose, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Legacy
 - 2. Speedaire
- B. Description: Hose reel shall be a premium-duty, lightweight, spring-retractable, ratcheted hose reel for applications that are less demanding, yet require a product that can withstand industrial and commercial use. The industrial-grade drive spring shall be protected from the environment in a steel or polypropylene spool for longer service life. An adjustable hose guide arm with roller guide assembly shall be provided that adjusts to at least seven positions. Unit shall be suitable for wall mounting, ceiling mounting, or floor mounting.
- C. Service: Suitable for securing a 35-foot-long, 3/8-inch ID x 0.600-inch OD hose.
- D. Construction: Reinforced steel - The steel guide arm and base shall be stamped with ribs and gussets to insure maximum strength and lightest possible weight.
- E. Finish: Quality finish and corrosion resistant - Individually powder coated components along with the composite spool offers the maximum protection from premature corrosion
- F. Color: Red
- G. Spool: Composite or reinforced steel material, including declutching arbor
- H. Axle: Full flow stress free swivel design - The full flow swivel shall combine the highest-grade seal design and materials with bearing areas to insure maximum service life. The supply hose is plumbed into the base to eliminate the risk of undue stress on the swivel.
- I. Pay-out / Retraction Mechanism: Long life steel drive spring with declutching arbor to eliminate reverse spring winding, and torsions latch spring is virtually unbreakable.
- J. Accessories:
 - 1. Isolation shut-off valve:
 - 2. OSHA Compressed Air Safety Shut Off Valve: McGuire Air Compressor SCVM4 Rated for shut-off at 70 to 78 SCFM at 90 psig.
 - 3. 1/2" x 36" inlet air hose – Reelcraft S601020-3 or equal
 - 4. 340-degree pivot base: Reelcraft 600608 or equal
 - 5. Hose: Heavy duty multi-purpose PVC nylon braid air hose, inside diameter 3/8-inch, outside diameter 0.600 Inch, fitting size 1/4 NPTM, pressure range 250 PSI minimum, color red, length 35-feet, coupled assembly, Reelcraft S601013-35 or equal. Provide 1/4-inch male disconnect on each end.
 - 6. Adjustable rubber hose bumper stop: Reelcraft 1-HR1004-A or equal.
 - 7. Female Quick disconnect hose coupler: 1/4" Parker EZ-251-6FP

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 - 2. NPS 2 and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
 - 3. NPS 2 and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
- B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 - 2. NPS 2 and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed or soldered joints.
 - 3. NPS 2 and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.
- C. Drain Piping: Use one of the following piping materials:
 - 1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.
 - 2. NPS 2 and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

3.2 VALVE APPLICATIONS

- A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Articles in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," according to the following:
 - 1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
 - 2. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
- B. General-Duty Valves for Aluminum Piping System: Provide valves, made by piping system manufacturer, that are compatible with piping.
 - 1. Ball Valves, NPS 2 and Smaller: NPT threaded ends, or push-connect bite ring ends.

3.3 HOSE REEL INSTALLATION.

- A. Provide solid mounting plate with drilled holes for each hose reel to be supported from.
- B. Extend compressed air piping to within 10-inches of the hose reel position, install at the 170-degree position of the 340-degree rotation pivot base.

- C. Connect the pivot base to mounting device and then the hose reel to the pivot base.
- D. Install hose bumper on hose at some reasonable position where the hose can be easily accessed.
- E. Provide an isolation valve on the end of the solid piping. Install the OSHA compressed air safety shut off valve downstream of the isolation valve and attach the short hose segment between the safety shut off valve and the hose reel inlet. Make sure the short hose does not restrict the pay-out of the hose reel hose.
- F. Adjust the tension on the spring in the hose reel for optimal force in retracting the hose.

3.4 PIPING INSTALLATION, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and machines to allow service and maintenance.
- F. Install air and drain piping with 1 percent slope downward in direction of flow.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
- H. Equipment and Specialty Flanged Connections:
 - 1. Use steel companion flange with gasket for connection to steel pipe.
 - 2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
- I. Flanged joints may be used instead of specified joint for any piping or tubing system.
- J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

- K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- N. Install piping to permit valve servicing.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.5 INSTALLATION OF ALUMINUM PIPING SYSTEMS

- A. Install aluminum piping systems according to manufacturer's written instructions, using manufacturer's recommended tools, accessories, and methods.
- B. Install branch connections NPS 2 and smaller, to compressed-air mains using aluminum piping system reducing outlet tee with water trapping capabilities. Provide drain leg and drain trap at end of each main and branch and at low points.
- C. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate shall be piped and connected to oil-water separator.
- D. Support aluminum pipe using manufacturer's hangers and supports, designed for use with the system.
- E. Allow for expansion and contraction of aluminum piping system.
- F. Do not use plastic components or plastic fittings of any kind within pressurized aluminum piping system. This applies to main headers, branches, and drops.

3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
- E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B828 or CDA's "Copper Tube Handbook."
- G. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- H. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
- I. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.7 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
- C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
- D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.8 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. NPS 2 and Smaller: Use dielectric unions.

3.9 FLEXIBLE PIPE CONNECTOR INSTALLATION

- A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.
- B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
- C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.10 SPECIALTY INSTALLATION

- A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
- B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
- C. Install air-line pressure regulators in branch piping to equipment and tools.
- D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
- E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.
- F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.
- G. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated.
- H. Install quick couplings at piping terminals for hose connections.
- I. Install hose assemblies at hose connections.

3.11 CONNECTIONS

- A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.12 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
 - 2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 3. NPS 1-1/2: 12 feet with 3/8-inch rod.
 - 4. NPS 2: 13 feet with 3/8-inch rod.
- I. Install supports for vertical, Schedule 40, steel piping every 15 feet.
- J. Install supports for vertical, Schedule 5, steel piping every 10 feet.
- K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
- L. Install supports for vertical copper tubing every 10 feet.
- M. Use manufacturer's recommended hangers and supports for aluminum piping system.
 - 1. Description: Wire rope using adjustable camlock system with standard threaded stud for connection to provided hangers.
 - 2. Hangers: UV-stabilized nylon and galvanized clevis style.
 - 3. Install hangers for aluminum piping every 8 feet.
 - 4. Install supports for vertical aluminum piping every 8 feet.

3.13 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.14 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating

pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of 15 psig, hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed 220 psig. Once desired operating pressure is met, let stand for one hour.
3. Repair leaks and retest until no leaks exist.
4. Inspect filters lubricators and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION

SECTION 22 15 19

GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Lubricated, reciprocating air compressors.
 - 2. Air-cooled, compressed-air aftercoolers.
 - 3. Refrigerant compressed-air dryers.
 - 4. Computer interface cabinet.

1.3 DEFINITIONS

- A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.
- B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For compressed-air equipment mounting.
 - 1. Detail fabrication and assembly of supports.
 - 2. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design compressed-air equipment mounting.
- B. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.3 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

- A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air. The Premium Package adds an electric drain, air-cooled aftercooler, low oil level switch and dual control with centrifugal unloader.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 4. Motor Overload Protection: Overload relay in each phase.
 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

6. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 1. Pressure Rating: At least as high as highest discharge pressure of connected compressors and bearing appropriate code symbols.
 2. Interior Finish: Corrosion-resistant coating.
 3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

2.4 LUBRICATED, RECIPROCATING AIR COMPRESSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Atlas Copco.
 2. Ingersoll-Rand.
 3. Quincy Compressor.
- B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
 1. Oil filter.
 2. Combined high discharge-air temperature and low lubrication-oil pressure switch.
- C. Capacities and Characteristics:
 1. Air Compressor(s): Two stage.
 2. Standard-Air Capacity of Each Air Compressor: Refer to schedule on plan.
 3. Discharge-Air Pressure: 125 psig.
 4. Motor (Each Air Compressor):
 - a. Horsepower: 15.
 5. Electrical Characteristics:
 - a. Volts: 480.
 - b. Phase(s): Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: 34.4.
 6. Receiver: ASME construction steel tank.
 - a. Arrangement: Horizontal.
 - b. Capacity: 120 gal.
 - c. Interior Finish: Epoxy coating.
 - d. Pressure Rating: 150 psig minimum.
 - e. Pressure Regulator Setting: 125 psig.
 - f. Pressure Relief Valve Setting: 140 psig.
 - g. Drain: Automatic valve.
 7. Enclosure: Steel with sound-attenuating material lining.

2.5 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.6 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

- A. Description: Integral with compressor.

2.7 REFRIGERANT COMPRESSED-AIR DRYERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Air/Tak, Inc.
 - 2. Atlas Copco.
 - 3. Ingersoll-Rand.
- B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.
- C. Capacities and Characteristics:
 - 1. Standard-Air Capacity of Each Compressed-Air Dryer: 75 scfm free air.
 - 2. Inlet Filter: 5 micrometers.
 - 3. Outlet Filter: 1 micrometer(s).
 - 4. Electrical Characteristics:
 - a. Volts: 120.
 - b. Phase(s): Single.
 - c. Hertz: 60.

2.8 COMPUTER INTERFACE CABINET

- A. Description:
 - 1. Wall mounting.
 - 2. Welded steel with white enamel finish.
 - 3. Gasketed door.
 - 4. Grounding device.
 - 5. Factory-installed, signal circuit boards.
 - 6. Power transformer.
 - 7. Circuit breaker.
 - 8. Wiring terminal board.
 - 9. Internal wiring capable of interfacing 20 alarm signals.

2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 - 1. Enclosure: Open, drip proof.
 - 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
 - 3. EXECUTION

2.10 EQUIPMENT INSTALLATION

- A. Equipment Mounting:
 - 1. Install air compressors on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- B. Install compressed-air equipment anchored to substrate.
- C. Arrange equipment so controls and devices are accessible for servicing.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Install the following devices on compressed-air equipment:
 - 1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
 - 2. Pressure Regulators: Install downstream from air compressors and dryers.
 - 3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

2.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221513 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to machine, allow space for service and maintenance.

2.12 IDENTIFICATION

- A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

2.13 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

2.14 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air compressors.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of commercial, electric, domestic-water heater.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Five years.
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A. O. Smith Corporation.
 - b. PVI; A WATTS Brand.
 - c. State Industries.
 - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 3. Standard: UL 1453.
 - 4. Storage-Tank Construction: ASME-code, steel vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.

- 2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless-steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- b. Pressure Rating: 150 psig.
- c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tapings.
5. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.
 - d. Jacket: Steel with enameled finish or high-impact composite material.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A. O. Smith Corporation.
 - b. AMTROL, Inc.
 - c. Flexcon Industries.
 2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
 3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
 4. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 5. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

- C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1
- D. Heat-Trap Fittings: ASHRAE/IES 90.1.
- E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- F. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- I. Fill electric, domestic-water heaters with water.
- J. Charge domestic-water expansion tanks with air to required system pressure.
- K. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION

SECTION 22 42 13.13

COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall-mounted water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.
 - 4. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

- A. Water Closets, Wall Mounted, Top Spud, Accessible: WC-1.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.

- d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - 3. Flushometer Valve: Refer to Flushometer Valve section.
 - 4. Toilet Seat: Refer to Toilet Seat section.
 - 5. Support: Water closet carrier.
 - 6. Water-Closet Mounting Height: and Handicapped/elderly according to ICC/ANSI A117.1.
- B. Water Closets, Wall Mounted, Top Spud: WC-2.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - 3. Flushometer Valve: Refer to Flushometer Valve section.
 - 4. Toilet Seat: Refer to Toilet Seat section.
 - 5. Support: Water closet carrier.
 - 6. Water-Closet Mounting Height: Standard.

2.2 FLUSHOMETER VALVES

- A. Solenoid-Actuator, Diaphragm Flushometer Valves:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC.
 - 2. Standard: ASSE 1037.
 - 3. Minimum Pressure Rating: 125 psig.
 - 4. Features: Include integral check stop and backflow-prevention device.
 - 5. Material: Brass body with corrosion-resistant components.
 - 6. Exposed Flushometer-Valve Finish: Chrome plated.
 - 7. Panel Finish: Chrome plated or stainless steel.
 - 8. Style: Exposed.
 - 9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 1.28 gal. per flush.
12. Minimum Inlet: NPS 1.

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Bemis Manufacturing Company.
 - c. Church Seats; Bemis Manufacturing Company.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial.
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

2.4 SUPPORTS

A. Water Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Josam Company.
 - b. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.
 - 2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:
 - 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - 2. Use carrier supports with waste-fitting assembly and seal.
- C. Flushometer-Valve Installation:
 - 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - 3. Install actuators in locations that are easy for people with disabilities to reach.
 - 4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- D. Install toilet seats on water closets.
- E. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 - 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Joint Sealing:
 - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to water-closet color.
 - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 42 13.16

COMMERCIAL URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall-hung urinals.
 - 2. Urinal flushometer valves.
 - 3. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

- A. Urinals, Wall Hung, Back Outlet, Siphon Jet, Accessible:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 - 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: Water saving.
 - f. Spud Size and Location: NPS 3/4; top.

- g. Outlet Size and Location: NPS 2; back.
- h. Color: White.
- 3. Flushometer Valve: Refer to Flushometer Valve section.
- 4. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
- 5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel up-rights.
- 6. Urinal Mounting Height: Standard and Handicapped/elderly according to ICC A117.1.

2.2 URINAL FLUSHOMETER VALVES

- A. Solenoid-Actuator, Diaphragm Flushometer Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Delany Products.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1037.
 - 3. Minimum Pressure Rating: 125 psig.
 - 4. Features: Include integral check stop and backflow-prevention device.
 - 5. Material: Brass body with corrosion-resistant components.
 - 6. Exposed Flushometer-Valve Finish: Chrome plated.
 - 7. Panel Finish: Chrome plated or stainless steel.
 - 8. Style: Exposed.
 - 9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 - 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 - 11. Consumption: 0.5 gal. per flush.
 - 12. Minimum Inlet: NPS 3/4.

2.3 SUPPORTS

- A. Type I Urinal Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - 2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
 - 1. Install urinals level and plumb according to roughing-in drawings.
 - 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 - 3. Install accessible, wall-mounted urinals at mounting height for the handi-capped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:
 - 1. Install supports, affixed to building substrate, for wall-hung urinals.
 - 2. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- C. Flushometer-Valve Installation:
 - 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
 - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - 3. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- D. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 - 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Joint Sealing:
 - 1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to urinal color.
 - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13

COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vitreous-china, counter-mounted lavatories.
 - 2. Automatically operated lavatory faucets.
 - 3. Supply fittings.
 - 4. Waste fittings.
 - 5. Lavatory supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory - Self-Rimming, Vitreous China, Counter Mounted:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Nominal Size:
 - 1) Round, 19 inches.
 - d. Faucet-Hole Punching: One hole.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Sealant.
- B. Lavatory - Vitreous China, Wall Mounted:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Kohler.
 - c. Zurn.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Nominal Size: Rectangular, 21 by 19 inches.
 - c. Faucet-Hole Punching: One hole.
 - d. Faucet-Hole Location: Top.
 - e. Color: White.
 - f. Mounting: For concealed-arm carrier.
 - 3. Support: Type II, concealed-arm lavatory carrier.
 - 4. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets - Automatic Type: Hardwired Electronic Sensor Operated, Mixing:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching's; coordinate outlet with spout and fixture receptor.
 - 5. Body Type: Single hole.
 - 6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 - 7. Finish: Polished chrome plate.

8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck.
10. Spout: Rigid, gooseneck type.
11. Drain: Not part of faucet.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
 1. NPS 3/8.
 2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 1. Size: NPS 1-1/2 by NPS 1-1/4.
 2. Material:
 - a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- C. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

3.6 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 42 16.16

COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Service basins.
 - 2. Sink faucets.
 - 3. Supply fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

- A. Service Basins MS-1: Terrazzo, floor mounted.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Fiat.
 - c. Stern-Williams Co., Inc.
 - 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square.

- c. Nominal Size: 36 by 36 inches.
- d. Height: 12 inches.
- e. Tiling Flange: Not required.
- f. Rim Guard: On all top surfaces.
- g. Drain: Grid with NPS 3 outlet.
- 3. Mounting: On floor and flush to wall.
- 4. Faucet: See "Sink Faucets" Article.

2.2 SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, two lever handle mixing valve.
 - 1. Commercial, Solid-Brass Faucets for MS-1:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Atlantic Metalworks.
 - 2) Chicago Faucets; Geberit Company.
 - 3) T&S Brass and Bronze Works, Inc.
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching's; coordinate outlet with spout and sink receptor.
 - 4. Body Type: Widespread.
 - 5. Body Material: Commercial, solid brass.
 - 6. Finish: Chrome plated.
 - 7. Maximum Flow Rate: 2.2 gpm.
 - 8. Handle(s): Wrist blade, 4 inches.
 - 9. Mounting Type: Back/wall, exposed.
 - 10. Spout Type: Rigid, solid brass with wall brace.
 - 11. Vacuum Breaker: Required for hose outlet.
 - 12. Spout Outlet: Hose thread according to ASME B1.20.7.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.

2.4 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Set floor-mounted sinks in leveling bed of cement grout.
- C. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 23

COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Shower faucets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For shower faucets to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- B. Shower Faucets:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Delta.
 - b. Leonard Valve Company.
 - c. Symmons.
 - 2. Description: Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
 - 3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.

- e. EPA WaterSense: Required.
- f. Mounting: Concealed.
- g. Operation: Single-handle, push-pull or twist or rotate control.
- h. Antiscald Device: Integral with mixing valve.
- i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 4. Supply Connections: NPS 1/2.
- 5. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: Fixed.
 - e. Shower-Arm, Flow-Control Fitting: 1.5 gpm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping"
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of showers, inspect and repair damaged finishes.
- B. Clean showers, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Combination units.
 - 2. Supplemental equipment.
 - 3. Water-tempering equipment.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and [mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ISEA Standard: Comply with ISEA Z358.1.
- C. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC A117.1, Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- E. Accessible, Plumbed Emergency Shower with Eye/Face Wash Combination Units:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bradley Corporation.
 - b. Guardian Equipment Co.
 - c. Haws Corporation.
 - 2. Piping:
 - a. Material: Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 - 3. Shower:
 - 4. Capacity: Not less than 20 gpm for at least 15 minutes.
 - a. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - b. Control-Valve Actuator: Pull rod.
 - c. Shower Head: 8-inch - minimum diameter, chrome-plated brass or stainless steel.
 - d. Mounting: In ceiling.
 - 5. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Recessed in wall.

2.2 WATER-TEMPERING EQUIPMENT

- A. Hot- and Cold-Water, Water-Tempering Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bradley Corporation.
 - b. Guardian Equipment Co.

- c. Haws Corporation.
- 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- F. Install thermometers in supply piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

SECTION 22 47 16

PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pressure water coolers and related components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers: Wall mounted , wheelchair accessible, and bottle filler.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
 - 2. Standards:
 - a. Comply with NSF 61 and NSF 372.
 - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
 - c. Comply with ICC A117.1.
 - 3. Cabinet: Bi-level with two attached cabinets and with a bi-level skirt kit, vinyl-covered steel with stainless-steel top.
 - 4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.

5. Control: Push bar.
6. Bottle Filler: Sensor activation with 20-second automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
7. Drain: Grid with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/2 brass P-trap.
10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
12. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/6.
 - 2) Volts: 120-V ac.
 - 3) Phase: Single.
 - 4) Hertz: 60.
 - 5) Minimum Circuit Ampacity: 15.
13. Support: Mounting frame or bracket for attaching to substrate.
14. Water Cooler Mounting Height: Handicapped/elderly according to ICC A117.1.

2.2 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.3 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and in-wall bottle filling stations to mounting frames.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations

where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping".

- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

2.4 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 ".
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

2.5 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

2.6 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 63 13

GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Argon piping designated "laboratory argon".
 - 2. Hydrogen piping designated "laboratory hydrogen".
 - 3. Nitrogen piping designated "laboratory nitrogen".
 - 4. Compressed Air piping, designated "Lab Compressed Air."
 - 5. Ball valves.
 - 6. Gas-service connections.
 - 7. Gas cylinder storage racks.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. Laboratory gas piping systems include nitrogen, compressed air, and hydrogen for laboratories.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Brazing certificates.
- C. Field quality control reports.
- D. Source Quality Control Reports:
 - 1. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For specialty gas piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications," or AWS B2.2/B2.2M.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory argon operating at 50 to 110 psig.
- B. Laboratory nitrogen operating at 160 to 185 psig.
- C. Laboratory compressed air operating at 50 to 110 psig.
- D. Laboratory hydrogen operating at 50 to 110 psig.

2.2 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 55

2.3 PIPES, TUBES, AND FITTINGS

- A. For all laboratory gases, all positive-pressure laboratory gas piping, tubing, and fittings shall have been manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
 - 1. Each length of tubing shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.
 - 2. Fittings and other components shall be delivered manufacturer sealed and labeled and kept sealed until prepared for installation.
- B. Copper Laboratory Gas Tube: ASTM B819, Type K and Type L, seamless, drawn temper. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.5 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged in accordance with CGA G-4.1 for oxygen service.
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Amico Corporation.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. NIBCO INC.
 - 2. Standard: MSS SP-110.
 - 3. Description: Three-piece body, brass or bronze.
 - 4. Pressure Rating: 300 psig minimum.
 - 5. Ball: Full-port, chrome-plated brass.
 - 6. Seats: PTFE or TFE.
 - 7. Handle: Lever.
 - 8. Stem: Blowout proof with PTFE or TFE seal.
 - 9. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
- C. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Marwin Valve; Richards Industries.
 - c. NIBCO INC.
 - 2. Description: In-line pattern, bronze.
 - 3. Pressure Rating: 300 psig minimum.
 - 4. Operation: Spring loaded.
 - 5. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
 - 6. Positive-pressure gas valves, for all gas types, shall be manufacturer cleaned, purged, and sealed for oxygen service, in accordance with CGA G-4.1.
 - a. Valves shall be delivered sealed and labeled and kept sealed until prepared for installation.

2.6 GAS CYLINDER STORAGE RACKS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Airgas, Inc.
 - 2. RT Racking Systems.
 - 3. USA Safety.
- B. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders, as indicated, or provide equivalent manufactured wall racks.
- C. Anchor holes in base to permit securing to the floor with anchor bolts supplied by the manufacturer.

- D. Rack Support Tubing: Minimum 2-inch by 2-inch by 1/8-inch tube steel finished with baked-on exterior grade polyurethane powder paint. All joints wrap-welded and polished.
- E. Tank Restraints: Dual minimum 5/16-inch steel welded link chain, electrically zinc-plated rated for 1,900 pounds with minimum 5/16-inch zinc-plated carabineer hooks rated for minimum 520 pounds.
- F. Comply with NFPA 55.
- G. Comply with OSHPD #OPA-2878-10.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gauges, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service in accordance with CGA G-4.1.
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING INSTALLATION

- A. General Location and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 55 for installation of laboratory gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.

- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and for branch connections.
- K. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- L. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
- C. Install pressure regulators on gas piping where reduced pressure is required.

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.
- D. Brazed Joints: Join copper tube and fittings in accordance with CDA's "Copper Tube Handbook," Ch. "Brazed Joints." Do not use flux. Continuously purge joint with oil-free, dry nitrogen during brazing.
- E. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings in accordance with ASTM B828.

- F. Flanged Joints:
 - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

3.5 GAS-SERVICE COMPONENT INSTALLATION

- A. Install gas manifolds anchored to substrate.
- B. Install gas cylinders and connect to manifold piping.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Vertical Piping: MSS Type 8 or Type 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52 spring hangers.
- F. Install hangers for copper tubing with maximum horizontal spacing and minimum rod diameters to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Support vertical runs of copper tubing to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems in accordance with NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Argon: White letters on green background.
 - 2. Lab Compressed Air: White letters on blue background.
 - 3. Hydrogen: Black letters on yellow background.
 - 4. Nitrogen: White letters on black background.

3.8 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect specialty gas regulators for proper operation.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, in accordance with "Preparation" Article.

3.10 PIPING SCHEDULE

- A. Laboratory Gas Piping NPS 3 and Smaller Shall Operate at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.

3.11 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions.

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SECTION 22 66 00

CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall piping.
 - 2. Neutralization tanks.
 - 3. Leak-detection systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For neutralization system and leak-detection system.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of neutralization-system assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include details of leak-detection-system assemblies. Indicate required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Neutralization-Tank Limestone: Equal to 200 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb bags.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
- B. Do not store plastic pipe or fittings in direct sunlight.

- C. Protect pipe, fittings, and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 70.

2.2 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water for 30 minutes.

2.3 SINGLE-WALL PIPE AND FITTINGS

- A. CPVC Drainage Pipe and Fittings: ASTM F2618, pipe and drainage-pattern fittings.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Spears Manufacturing Company.
 - 2. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
- B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.4 JOINING MATERIALS

- A. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
- D. Solvent Cement for Joining CPVC Piping: ASTM F493. Include primer in accordance with ASTM F656.

2.5 PIPING SPECIALTIES

- A. Corrosion-Resistant Traps:
 - 1. Type: P-trap or drum trap.
 - 2. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.

3. High-Silicon Iron: ASTM A861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
 4. PP: ASTM D4101, with mechanical-joint pipe connections.
- B. PP Sink Outlets:
1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch-high overflow fitting.

2.6 NEUTRALIZATION TANKS

- A. Plastic Neutralization Tanks
1. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, side-wall pipe connections.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Park.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 3. Source Limitations: Obtain tanks from single source from single manufacturer.
 4. Material: HDPE.
 5. Tank Capacity: 300 gallons.
 6. Extension: HDPE, PE, or PP.
 7. Traffic Cover: Heavy-duty pedestrian or light-duty vehicular, steel plate over plastic, bolted.

2.7 LEAK-DETECTION SYSTEMS

- A. Leak-Detection Systems.
1. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Asahi/America.
 - b. Park.
 - c. Perma-Pipe, Inc.
 3. Source Limitations: Obtain leak-detection systems from single source from single manufacturer.
 4. Annunciator Panel: Enclosure with visual and audible alarms and leak-location indicator.
 5. Sensors: Electric cable, suitable for insertion in double containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Civil specifications for excavating, trenching, and back-filing.

3.2 PIPING INSTALLATION

- A. Chemical-Waste Sewerage Outside the Building:
 - 1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
 - 2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for using lubricants, cements, and other installation requirements.
 - 3. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
 - 4. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
 - 5. Install CPVC drainage piping in accordance with ASTM D2321 and ASTM F1668.
 - 6. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain a swab or drag inside piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.
- B. Chemical-Waste Piping Inside the Building:
 - 1. Install piping adjacent to equipment, accessories, and specialties, to allow space for service and maintenance.
 - 2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
 - 3. Flanges may be used on aboveground piping unless otherwise indicated.
 - 4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 - 5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - 6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - 7. Install piping at indicated slopes.
 - 8. Install piping free of sags and bends.
 - 9. Install fittings for changes in direction and branch connections.
 - 10. Verify final equipment locations for roughing-in.
 - 11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

12. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
13. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground single-wall piping.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
 1. Vertical Piping: MSS Type 8 or MSS Type 42 riser clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
- C. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- E. Support vertical piping and tubing at base and at each floor.
- F. Rod diameter may be reduced one size for double-rod hangers, to minimum of 3/8 inch.
- G. Install supports for vertical CPVC piping every 72 inches.
- H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 36 inches with 3/8-inch rod.
 2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- I. Install supports for vertical CPVC piping every 48 inches.
- J. Support piping and tubing not listed above in accordance with MSS SP-58.

3.4 NEUTRALIZATION TANK INSTALLATION

- A. Install exterior neutralization tanks, complete with appurtenances indicated.
 1. Set tops of tank covers flush with finished surface where covers occur in pavements. Set covers 3 inches above finished surface elsewhere unless otherwise indicated.
 2. Include initial fill of limestone for neutralization tanks.

3.5 LEAK-DETECTION SYSTEM INSTALLATION

- A. Tanks: Install leak-detection system around bottom of exterior.
- B. Install panel in location indicated.

3.6 CONCRETE PLACEMENT

- A. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete supports.
- B. Place cast-in-place concrete in accordance with ACI 318/318R.

3.7 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.8 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.
 - 1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.9 ADJUSTING

- A. Adjust neutralization-system set points.

3.10 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Clean piping by flushing with potable water.

3.11 STARTUP SERVICE

- A. Perform startup service for neutralization systems and leak-detection systems.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Neutralization Systems:
 - a. Verify that neutralization system is installed and connected according to the Contract Documents.
 - b. Verify that electrical wiring installation complies with manufacturer's submittal.
 - c. Install neutralizing solutions and limestone.
 - d. Energize circuits.
 - e. Start and run systems through complete sequence of operations.
 - f. Adjust operating controls.
 - 3. Leak-Detection Systems:
 - a. Verify that electrical wiring installation complies with manufacturer's submittal.
 - b. Energize circuits.
 - c. Adjust operating controls.

3.12 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Hydrostatic Tests for Drainage Piping:
 - 1) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile of pipe during 24-hour period.
 - 2) Close openings in system and fill with water.
 - 3) Purge air and refill with water.
 - 4) Disconnect water supply.
 - 5) Test and inspect joints for leaks.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Submit separate reports for each test.
- B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
- C. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.13 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain neutralization systems and leak-detection systems.

3.14 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Single-Wall, Chemical-Waste Sewerage Piping: Use the following piping materials for each size range:
- C. NPS 1-1/2 to NPS 4: CPVC drainage pipe and fittings and solvent-cemented joints.
- D. Aboveground Chemical-Waste Piping: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6: CPVC drainage piping and solvent-cemented joints.
- E. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use the following piping materials for each size range:
1. NPS 1-1/2 to NPS 6: CPVC drainage piping and solvent cemented joints.

END OF SECTION

SECTION 22 67 13

PROCESSED WATER PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes deionized-water piping, fittings, and valves, including the following:
 - 1. CPVC pipe and fittings.
 - 2. PVDF pipe and fittings.
 - 3. CPVC valves.
 - 4. PVDF valves.

1.3 DEFINITIONS

- A. RO: Reverse osmosis.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.3 for piping conveying fluid at a pressure of 15 psig or greater.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure Ratings:
 - 1. Deionized-Water Piping: 100 psig unless otherwise indicated.

2.2 PLASTIC PIPE AND FITTINGS

- A. Standards: Comply with NSF 14, NSF 61, and NSF 372.
- B. CPVC Pipe and Fittings, Schedule 80: ASTM F441/F441M pipe; with plain ends for solvent-cemented joints and ASTM F439 socket-type fittings.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Asahi/America.
 - 2. GF Piping Systems.
 - 3. Spears.
- D. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- E. PVDF Pipe and Fittings: Made from ASTM D3222 PVDF resin.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Asahi/America.
 - b. Georg Fischer Inc.
 - c. Orion Fittings; A WATTS Brand.
 - 2. PVDF Pipe and Fittings, Schedule 80: Pipe made in accordance with ASTM D3222, Schedule 80 or SDR; with socket-fusion fittings matching pipe dimensions.

2.3 TRANSITION FITTINGS

- A. Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to, and ends compatible with piping to be joined.

2.4 CPVC VALVES

- A. CPVC Diaphragm Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Asahi/America.
 - b. Georg Fischer Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: 150 psig at 73 deg F.
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: Bolted-bonnet type.
 - e. End Connections for NPS 2 and Smaller: Detachable, socket.
 - f. Diaphragm: EPDM rubber.
 - g. Seals: EPDM-rubber O-rings.
 - h. Handle: Wheel type.
 - i. Handle: Wheel type.

2.5 PVDF VALVES

A. PVDF Diaphragm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Asahi/America.
 - b. Georg Fischer Inc.
 - c. NIBCO INC.
2. Description:
 - a. Pressure Rating: 150 psig at 73 deg F.
 - b. Body Material: ASTM D3222 PVDF resin.
 - c. Body Design: Bolted-bonnet type.
 - d. End Connections for NPS 2 and Smaller: Detachable, socket.
 - e. Diaphragm: FKM rubber.
 - f. Seals: FKM-rubber O-rings.
 - g. Handle: Wheel type.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. General Locations and Arrangements: Drawing and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.

- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. CPVC Piping Solvent-Cemented Joints: Comply with ASTM F402 for handling solvent cements, primers, and cleaners; make joints in accordance with ASTM D2846/D2846M Appendix.
- C. PVDF Piping Heat-Fusion Joints: Make in accordance with ASTM D2657.
- D. Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.3 INSTALLATION OF VALVES

- A. Install sectional valves close to mains on each branch and riser serving equipment.
- B. Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves of same size as the pipe or tube in which they are installed unless otherwise indicated.
- E. Install plastic valves of the same material as the plastic pipe in which they are installed.
- F. Install valves in horizontal piping with stem at or above center of pipe.
- G. Install valves in position to allow full movement of stem and lever handle.
- H. Install swing-check valves in horizontal position with the hinge pin level.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 3. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
 4. Clamps for Vertical Piping: MSS Type 8 or Type 42.
 5. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1 adjustable clevis hangers.
 6. Multiple, Straight, Horizontal Piping Runs, 100 Feet or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 7. Base of Vertical Piping: MSS Type 52 spring hangers.
- B. Install hangers for stainless steel tubing with the maximum horizontal spacing and minimum rod diameters to comply with MSS SP-58, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - C. Install padded hangers for CPVC and PVDF piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written recommendations, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - D. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
 - E. Support vertical runs of CPVC and PVDF piping to comply with manufacturer's written recommendations, NFPA 99, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect deionized-water piping to equipment and service outlets with unions or flanges.

3.6 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- D. Tests and Inspections:
 - 1. Test completed piping in accordance with authorities having jurisdiction. If authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Hydrostatic Tests: Test piping at pressure of not less than 1-1/2 times the maximum system operating pressure, but not less than 50 psig. Hold test for two hours; pressure shall remain constant without pumping. Inspect system to determine visible leaks or significant pressure variations.
 - 1) Exception: Do not subject glass piping to pressure above manufacturer's pressure rating for size.
 - 2. If piping does not pass the test, replace leaking joints with new materials and re-test until no leaks exist.
 - 3. Submit separate reports for each test.
- E. Processed-water system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 CLEANING OF PIPING SERVING LABORATORIES

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.
 - 2. Remove flow indicators and flow-measuring devices before flushing. Replace after cleaning is completed.
 - 3. Provide storage tank(s), heat exchanger(s) and pumping system(s) required for cleaning.
 - 4. Clean piping by pumping at a sufficient velocity and quantity to dislodge sediment or dirt with sodium hypochlorite and deionized- water mixture throughout the system.
 - 5. Open all taps until cleaning solution is detected, then close taps. Retain solution in the system at least four hours.
- B. At the end of the retention period, open all faucets and taps to thoroughly flush with clean deionized- water until solution is drained from the system.

3.9 PIPING APPLICATION

- A. Transition and special fittings with pressure ratings at least equal to piping, and of same or compatible material, may be used in applications below.
- B. Pipe fittings shall be the same material as the piping to which it is connected.
- C. Deionized-Water Piping: Use any of the following piping materials for each pipe size range:
 - 1. NPS 3 and Smaller: CPVCP pipe and fittings and solvent cemented joints.
 - 2. NPS 3 and Smaller: PVDF pipe and fittings and heat-fusion joints.

3.10 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Valves shall be the same material as the piping to which they are connected.

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SECTION 22 67 19

HIGH PURITY WATER SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section includes the equipment requirements for the Reverse Osmosis (RO) / Deionized (DI) water systems:
 - 1. Carbon filter/water softener.
 - 2. Reverse osmosis (RO) systems.
 - 3. Electro deionization (EDI) systems
 - 4. RO water storage tanks.
 - 5. Re-pressurization pumps.
 - 6. Deionized (DI) mixed beds.
 - 7. Ultraviolet (UV) sterilizers.
 - 8. Final filters.
- B. The RO and DI systems Vendor shall be responsible for the design, procurement, fabrication, and delivery of skid assemblies, equipment, valving, controls and all loose shipped materials required for a complete, operating system. Installation of equipment and interconnecting piping, wiring, and controls will be by the Mechanical and Electrical Contractors under the supervision of the RO/DI systems Vendor.
- C. The Vendor shall provide assistance in system commissioning, as specified herein.
- D. Refer to the Drawings for work covered by these specifications.

1.2 QUALITY ASSURANCE

- A. Installer qualifications: Manufacturer, of reputable, established organization regularly engaged in supply and servicing high purity water systems, including providing engineering services.
- B. All RO/DI system components shall be furnished by a single supplier.

1.3 RELATED WORK

- A. Work by Others: The Vendor is responsible for fabrication, procurement, and delivery of all components of the RO/DI system except as specified herein. Installation responsibilities by others shall include:
 - 1. Installation of Vendor-furnished equipment.

- B. Furnish and installation of interconnecting piping and valves between Vendor-furnished skids and/or Vendor-furnished equipment, based on fabrication drawings provided by the Vendor.
- C. Furnish and installation of power and control wiring to Vendor furnished control panels and skid-mounted disconnects for feeds to skid-mounted equipment, based on wiring schematics provided by the Vendor.
- D. Wiring of Building Management System (BMS) inputs from Vendor furnished control panel or devices to the BMS system I/O cabinet(s).
- E. Furnish and installation of the RO/DI water distribution piping.
- F. Furnish and installation of off-site regenerate mixed bed ion exchangers.
- G. Work of other Mechanical Specifications:
 - 1. General and special mechanical requirements.
 - 2. Plumbing systems.
 - 3. Pipe hangers and supports.
 - 4. Piping and equipment identification.
 - 5. High purity water piping system.
- H. Refer to Electrical specifications for electrical requirements:
 - 1. Electrical work.
 - 2. Variable frequency controllers.
 - 3. Medium voltage cables.
 - 4. Motor starters and motor control centers.
- I. Refer to Integrated Automation Division for instrumentation and controls requirements.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Process flow schematic of the proposed system, showing all equipment and accessories, major flow piping, sizes, flow rates, and field connections.
 - 2. P&ID of the proposed system, with all equipment, accessories, piping, meters and gauges, instrumentation and control devices, and major control loops.
 - 3. Equipment and component layout.
 - 4. Drawings for interconnecting piping systems.
- B. Product Data:
 - 1. Performance data, including pump curves.
 - 2. Physical dimensions and weight data.
 - 3. Piping diagrams and field connections.
 - 4. Electrical and controls wiring data, and field connections.
 - 5. Wiring diagrams showing terminations for all interconnecting power and control wiring between panels and skids, including wiring to devices that are field installed.
 - 6. Panel layouts.
 - 7. Project specific Sequence of Operations (SOO).

- C. Contract Closeout Information:
 - 1. Operating and maintenance data.
 - 2. Instrumentation and controls data.
 - 3. Start-up report.
 - 4. Warranty.

1.5 DESIGN CRITERIA

- A. The RO/DI water system shall be designed to circulate 9 GPM water supply to the facility at 80 PSIG supply pressure, with a production rate of 500 GPD.
- B. The RO/DI water system shall be designed to the following make up water conditions (supplied from the domestic water system). Vendor shall be responsible for verification of make-up water characteristics:
 - 1. Temperature (°F) 55 – 86 range.
 - 2. Pressure (psig), min 55.
 - 3. pH (pH units) 7.2 – 9.0 range.
 - 4. Hardness (mg/l as CaCO₃) 69 – 290 range.
 - 5. Silica (mg/l as SiO₂) 9 – 32 range.
 - 6. Chlorine (mg/l as Cl) 37 – 280 range.
 - 7. Alkalinity (mg/l as CaCO₃) 56 – 210 range.
 - 8. Conductivity (micro-siemens/cm) 801 – 1660 range.
 - 9. Magnesium (mg/l as Mg/CaCO₃) 16 – 44 range.
 - 10. Total Dissolved Solids (mg/l) 180 – 780 range.
- C. System performance criteria (product RO/DI water quality) shall meet ASTM Type I as follows:
 - 1. Resistivity, min.= 18 megohm @ 25° C.
 - 2. Conductivity, max. = 0.056 micromhos/cm @ 25° C.
 - 3. pH, units = Not Applicable at 25° C.
 - 4. Total Organic Carbon, max.= 50 ug/l.
 - 5. Sodium, max. = 1 ug/l.
 - 6. Chloride, max. = 1 ug/l.
 - 7. Total Silica, max. = 3 ug/l.
- D. The RO/DI water storage tank capacities, sizes, and connections shall be as indicated on the drawings.

1.6 FACTORY TESTING

- A. Vendor shall perform factory testing of all factory-assembled components and skid assemblies prior to shipment and certification shall be furnished.
- B. The piping subassemblies shall be hydraulically leak tested as specified herein.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Shipment:
 - 1. Each skid or equipment item shall be suitably prepared for the shipment in a manner requiring minimum re-assembly prior to operation.

2. Equipment and components shall be completely free of water prior to any shipment preparation.
3. Adequate protection shall be provided against mechanical damage.
4. The following shall be shipped to prevent freezing and exposure to temperature extremes in excess of manufacturer's recommendations:
 - a. RO membranes.
 - b. Ion exchange resin.
5. All instruments and valves, including auxiliary systems, must be securely mounted and/or supported to eliminate damage during shipment, and storage.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable manufacturers:
 1. RO/DI water system:
 - a. Base: R500SA-M1-MTM1-2-EDI-D05-X4-AC175-PV9-80-VX2-F42
 - 1) Water Control Corporation (866-405-1268)
 - b. Optional:
 - 1) Culligan.
 - 2) Nancrede.
 - 3) Marlo.
- B. The RO/DI system shall consist of completely new components, as specified herein and as indicated on the drawings.
- C. System shall be designed and guaranteed by the Vendor to produce water to meet the specifications in this section.
- D. Equipment Packages:
 1. Mounting Skids: Each equipment skid shall include an aluminum base such that there is an even distribution of the equipment weight on the floor and, when fully loaded, there will be no distortion or unequal stresses upon equipment or face piping. Skid piping, valving, and instrumentation shall be completely supported from structural frame or vessel to prevent distortion from the vertical and horizontal planes. Upon arrival at the jobsite, skid piping shall be level with the vertical and horizontal planes over the skid length.
 2. The surface finish of the vessels, skids, and other ferrous metallic surfaces shall be powder-coated white.
 3. All equipment shall be mounted to allow adequate clearance to all service points.
 4. Where applicable, control panel shall be provided installed on skid. The panel rating shall be NEMA 4 minimum or equivalent. All instruments installed on the skid shall be wired to terminal blocks installed in the panel.
- E. General:
 1. Equipment and piping labeling shall be located in a manner such that it is easily visible and accessible to operators during normal operation of the equipment. Control components identification shall match the labels and identifiers shown on the P&IDs.

2. Instrumentation and controls shall be mounted in a manner so as to be easily visible and accessible to the operators for use, calibration, maintenance, and replacement.
 3. All conduit, mechanical, and process piping shall be sufficiently supported from powder-coated aluminum skid.
- F. Piping:
1. Piping configurations shall not block maintenance access and shall not block operator viewing of vessel sight glasses and instrumentation.
 2. Resistivity, conductivity, and pH probes shall be installed in accordance with manufacturer's instructions.
- G. Extra Stock:
1. For each filter component, provide one full set of sacrificial filter cartridges for startup, and one full set of spare filter cartridges.

2.2 CARBON FILTER/WATER SOFTENER

- A. Combination carbon filter/water softening system: Vertical pressure type ion exchanger system with regenerating equipment, complete with components required to insure proper operation.
- B. The water filter/softening system shall consist of two resin tanks. During normal operation, one tank will be in service with the other in standby. Controller shall only allow one tank to regenerate at a time.
- C. Resin tank: Fiberglass reinforced molded thermoplastic inner shell with dished heads, equipped with reinforced openings for control valve connections.
- D. Internal distribution: Design underdrain system to uniformly collect softened water as well as distribute backwash laterally across entire bed:
1. Header-lateral construction with minimum of 2 plastic strainers per 1 SF of bed area.
 2. Furnish gravel sub-fill only, not extending above strainers.
- E. Upper distribution system: Header-lateral manifold type arranged for uniform distribution of both brine solution and raw waste, as well as collection of backwash:
- F. Construct both upper and lower distributors of an approved non-corrosive material.
- G. The filter shall be system for removal of residual chlorine and the reduction of nonpolar organics (TOC) from the city granular activated carbon (GAC) required in the pretreatment/makeup water inlet water. The activated carbon filter shall produce water having a residual chlorine concentration of less than 0.1 ppm when operated at the normal service conditions.
- H. Ion exchange resin: High capacity sulfonated polystyrene type requiring no chemicals other than sodium chloride to obtain specified capacity.

- I. Controls:
 - 1. The softener tank shall be provided with a water volume initiated 5 cycle fully automatic regeneration, managed by a solid-state electronic controller featuring:
 - a. Fully programmable cycle times.
 - b. Service and standby modes.
 - c. Water volume totalizer and flow rate displays.
 - d. System status indicator lights.
 - e. Provisions for additional auxiliary outputs.
- J. Brine tank: Rigid, molded polyethylene:
 - 1. Fresh make-up water shall flow downward through solid salt controlled by float valve in salt storage tank.
 - 2. Provide automatic valve to control amount of brine draw.
 - 3. Provide necessary valves, educator and piping.
 - 4. Size: Large enough for a minimum of four (4) regenerations at full salting.
- K. Provide water testing kit to make chemical tests necessary for controlling operation and adjustments of brine dosage.
- L. Size and capacity as shown on drawings.

2.3 REVERSE OSMOSIS (RO) SYSTEMS

- A. Design Criteria: The reverse osmosis unit shall be designed to comply with the specified performance requirements.
- B. The reverse osmosis unit shall be supplied complete with membrane elements, pressure vessels, interconnecting piping and valves, instrumentation and controls, sample taps, pressure gauges, pump control, control panel, and support structure.
- C. Vessels/tubes:
 - 1. The RO vessels shall be PVC with easy-to-remove snap ring and removable end cap.
 - 2. Shall include double O-ring permeate seals.
- D. Membrane elements:
 - 1. Membranes shall be Thin-film composite with FRP over-wrap, capable of 99% rejection at 100 psi.
 - 2. Furnish EPDM or Viton O-rings, gaskets, and seals. Furnish interconnectors and any other hardware required for a complete system.
Controls: Solid state electronic controller.
 - 3. Flow, temperature, resistivity, and pressure transmitters and indicators shall be supplied as required for a complete and operating system
 - 4. Flow elements and indicators are required on the feed, product, recycle and reject streams. Includes percent recovery and rejection.
 - 5. Resistivity elements and indicators are required on the feed and product streams.
 - 6. Pressure transmitters and indicators are required on the pre-filter, pump discharge, product and reject streams.
 - 7. OPTIONAL - Provide controls interface compatible with the facility control system.

- E. Size and capacity as shown on drawings.

2.4 ELECTRODEIONIZATION SYSTEMS

- A. Provide SnowPure Water Technologies Electropure™ brand continuous electro deionization (EDI aka CEDI or CDI™) modules for an EDI system to be manufactured by an approved fabricator who is regularly engaged in the production and integration of water treatment equipment.
- B. Qualified manufacturers of EDI modules, which are used in the fabrication of an EDI system, must be engaged in the manufacture of modules since 1977. Acceptable manufacturers are SnowPure Water Technologies, Electropure™ brand, or the Engineer's approved equal.
- C. GENERAL DESCRIPTION
 1. Specifications are based upon SnowPure Water Technologies Electropure™ EDI modules utilizing thin-cell efficient technology. Concentrate recirculation or brine injection must not be required for operation of the module(s). SnowPure Water Technologies patented Excellion™ cation and anion membrane must be used in EDI module construction together with a non-scaling EDI electrode system. The purpose of electro deionization (EDI) is to produce ultrapure water by removing charged ions from water that has been pre-treated by a one-pass or two-pass reverse osmosis (RO) system. EDI modules contain mixed-bed ion exchange resins which do not require a chemical regeneration step. Ions are continuously transported out of the permeate stream and into the concentrate by a DC current, requiring a properly sized DC power supply. Chemicals must not be required for EDI operation or regeneration.
 2. EDI modules must be installed per guidelines found in SnowPure Water Technologies operating manual titled: "OEM Engineering Manual Electropure™ XL & EXL Series EDI" which contains information for the successful system engineering, design, installation, operation, and maintenance of "Electropure™ XL and EXL" EDI products. The water system integrator (OEM) must be trained, qualified, and approved by SnowPure Water Technologies and fabricate the equipment in accordance with their "Best Practices" P&ID diagrams.
 3. The EDI modules must have the following three key advantages that enable higher efficiency and longer life, with less maintenance and fewer performance issues:
 - a. 1. Thin-Cell Technology In EDI, there is a physical competition to drive ions horizontally across the cell before they leave the top of the cell. Electropure™ XL cells are 4mm wide, as compared to other cells which are about 10 mm wide. Thin cells allow higher water quality and higher efficiency.
 - b. 2. Thin-Concentrate Technology Electropure™ EDI uses a very thin concentrate chamber, about 700 microns thick. It is made up of very thin woven fibers. This design creates turbulence at the membrane surface, keeping the membrane surfaces clean and close to pH 7, preventing fouling and scaling. The thin design also keeps the current low. Electropure™ avoids the use of a "filled concentrate" which can foul. The all-filled design was contemplated by Electropure's founder and

inventor of EDI technology in the 1981 O'Hare patent, but was rejected because of its long-term problems.

- c. 3. Non-fouling Electrode Technology Electropure™ EDI uses a special anode technology to limit the production of chlorine; this lengthens the life of the EDI module. It also uses a proprietary design which keeps the electrodes always on the acidic side, preventing scaling in the electrodes. With these technologies scaling in systems is extremely rare. EDI module lifetime is designed be long (longest life seen so far is 15 years). SnowPure intentionally uses technologies in its products that minimize maintenance and maximize module lifetime.

D. PERFORMANCE AND DESIGN DATA

1. High inlet conductivity levels into an EDI device will reduce the resistivity of the outlet water. A common cause of the high conductivity is dissolved carbon dioxide (CO₂). The overall performance of an RO-EDI system can be improved by removing dissolved CO₂ before the EDI units. Membrane contactors (membrane de-gasifiers) provide a clean, chemical-and-maintenance-free method to remove CO₂ from RO permeate without any pH adjustment. These are highly recommended by SnowPure for this purpose and to provide a low maintenance, chemical free, high purity water system.
2. DESIGN PARAMETERS

EDI Operating Feed Water Specifications

The following are requirements to operate within SnowPure's limited warranty. Optimum performance from Electropure™ EDI modules will result if values that are more stringent are set as design goals.

Specification	Notes	Working Range	Optimum Performance
Feedwater Source	RO water, direct feed, or with intermediate break tank plus filter		
EDI Feed Conductivity	Ionic load determines size of the working bed and polishing bed within the EDI	1-20 µS/cm	1-6 µS/cm
Feedwater Conductivity Equivalent (FCE) **	FCE is a demand load indicator for EDI. Calculate FCE as follows: $FCE = \text{Conductivity} + 2.79 * (CO_2) + 1.94 * (SiO_2)$ (**see example below)	<52 µS/cm	<9 µS/cm
pH	Low pH feedwater typically indicates the presence of CO ₂ which will decrease quality	5.0 – 9.5	7.0 – 7.5
Total CO ₂	Combined CO ₂ and HCO ₃	<5 mg/l as CO ₂	<2 mg/l
Operating Temperature	Standard XL-Models XL-HTS Models (high temperature)	5°C to 35°C 5°C to 45°C	5°C to 30°C 5°C to 30°C
Hardness	Ca and Mg as CaCO ₃	<1.0 mg/l at 90% recovery	

Specification	Notes	Working Range	Optimum Performance
Organics	TOC	<0.5 mg/l	Not Detectable
Metals	Fe, Mn, transition metals	<10 ppb	Not Detectable
Silica, SiO ₂	Typically dissolved, reactive	<0.5 mg/l	<0.2 mg/l
Oxidizers	Cl ₂ and O ₃ , typically	Not Detectable	Not Detectable
Particles	Recommended direct feed particle-free RO permeate or 5-10 µm pre-filtration of feed from intermediate tank		
Inlet Pressure	Depends on flow and temperature	XL: 5 bar (75 psi) max EXL: 7 bar (100 psi) max	2-3 bar typical
Outlet Pressure	Concentrate and Electrode outlet pressures to be lower than the Product outlet pressure		

** FCE Example:

FCE = Conductivity + 2.79*(CO₂) + 1.94*(SiO₂), so if conductivity = 5.0 us/cm, CO₂ = 3.5 mg/l, SiO₂ = 0.5 mg/l,
then FCE = 5.0 + 2.79*(3.5) + 1.94*(0.5) = 15.7 us/cm FCE

3. EDI PERMEATE WATER QUALITY

- a. An estimated EDI permeate water quality can be provided by utilizing SnowPure's EDICAD™ computer software program. The program projects EDI quality based upon an RO permeate water analysis. The results help guide the system engineer during the EDI design and bid phase by determining the number of modules needed and to estimate the final performance of a pure water integrated system.
- b. EDICAD™ uses specific ion feed from the RO permeate estimate/analysis to compute the variables critical for optimal EDI system design and operation. These estimates include:
 - 1) Product resistivity (MΩ.cm)
 - 2) Silica content (ppb)
 - 3) Expected electrical cost (based on the input cost/kWh)
 - 4) Pressure drops, and more

4. OPTIMIZED RECOVERY FOR RO/EDI

- a. SnowPure Water Technologies Electropure™ modules are designed for high recovery from 90 to 99% depending upon feed water quality and overall system design. For example, at 90% recovery of permeate, the remaining concentrate stream can be returned to the beginning of process rather than sent to drain. As EDI concentrate is higher in quality than first pass RO feed it is beneficial to return this concentrate to the inlet of the RO rather than to drain. Waste to drain will not only be significantly

reduced but with high-quality EDI concentrate returning to RO feed a higher recovery rate of 5-10% may be realized in the first pass RO system. Please note that the flow rate of the EDI electrode stream is very small and also contains chlorine, which will damage both the RO and EDI and so therefore the electrode stream must always be sent to drain. There should also be no back-pressure present on the Electrode, Permeate or Concentrate EDI streams.

E. INSTRUCTIONS

1. One (1) complete sets of installation, operating, and maintenance manuals shall be provided.

F. WARRANTY

1. A single written warranty must be provided from the manufacturer of the electro deionization modules covering workmanship and materials.

2.5 RO/DI WATER STORAGE TANKS

- A. A water storage tanks shall be provided to allow retention time for product water distribution for each system.
- B. Tanks shall be manufactured of linear, rotationally molded polyethylene with extra heavy wall construction.
- C. Fabrication:
1. The tanks shall be vertical with cone bottoms and straight sides.
 2. Manways shall be provided with all necessary gaskets and covers.
 3. The final locations of nozzles and accessories shall be subject to change until shop drawing approval.

2.6 REPRESSURIZATION PUMPS

- A. Each pump shall be an integral unit consisting of 316 stainless steel vertical multistage centrifugal pump and motor.
- B. Pump shall be non-contaminating and designed for the high purity service intended.
- C. Single external mechanical seal model shall have silicon carbide/silicon carbide surfaces, and stainless-steel metallic parts. Elastomers shall be EPDM.
- D. All pumps shall be sized such that the impeller required at the given maximum flow and head is midrange of the impellers available in the casing provided. Motor horsepower shall be sized to prevent motor overloading at reduced system head.
- E. Operating point shall not be to the right of the maximum efficiency on the pump curve.
- F. Motor enclosures shall be TEFC. Motors shall be inverter duty rated, suitable for adjustable frequency drive operation, and 460 V, 60 Hz service.

2.7 DEIONIZED (DI) MIXED BEDS

- A. Mixed bed ion exchange vessels shall be Service Deionization (SDI) type, with quick connect fittings on inlet and outlet to facilitate removal for off-site regeneration.
- B. Resin furnished shall be suitable for use in polish mixed bed deionizer application and for the intended application. The Vendor shall confirm with resin manufacturer the best vessel design to support the resin's unique characteristics.
- C. Equipment – vessels:
 - 1. Each vessels volume shall be 0.5 cubic feet.
 - 2. Vessels shall be filament wound FRP, ASME code rated at 150 PSI working pressure.

2.8 ULTRAVIOLET (UV) STERILIZERS

- A. Design:
 - 1. For Bacteria destruction the ultraviolet light wavelength shall be 254 nm.
 - 2. The UV dosage shall be at least 40,000 mws/cm² at 254 nm after 9,000 hours of operation time.
- B. General: As a minimum, ultraviolet sterilizers shall each have the following:
 - 1. Single high-output lamp in a quartz tube with electrical connections at one end.
 - 2. Single quartz sleeve to isolate the lamp tube from the product water.
 - 3. UV monitor for continuous indication of UV lamp intensity.
 - 4. An integral power-stepping function to maintain constant UV dosage during life of the UV lamp.
- C. Construction:
 - 1. Wetted surfaces of the UV sterilizer chamber and other components shall be 316L stainless steel.
 - 2. Quartz sleeves shall be watertight to allow lamp changeout without draining the chamber.
 - 3. Inlet and outlet piping connections to the UV sterilizers shall include a light trap, of at least one stainless steel 90-degree elbow and 2 feet of pipe shall be provided at each connection.
- D. Power Panels:
 - 1. The sterilizer power panels shall be controlled and powered, and at a minimum, provide local indication of the following:
 - a. Lamp ON/OFF status.
 - b. Lamp intensity.
 - c. Lamp run time.
 - d. Alarm status lights.
 - 2. The UV sterilizers shall be configured such that, if power to the UV sterilizer is interrupted or lost, the UV sterilizers automatically restart once the power source is regained.

2.9 FINAL FILTERS

- A. High purity cartridge filter housings and elements for DI water final filtration.
- B. Filter housings:
 - 1. Housing and cap shall be constructed of polypropylene and shall include EPDM and Buna-N elastomers.
- C. Filter elements:
 - 1. Filter elements shall be a thermally bonded blend of micro glass fibers and cellulose infused with nano alumina fibers in a non-woven matrix that creates an electro positively charges depth filter.
 - 2. Final filters shall have a rating of 0.2 micron absolute.

2.10 Control Panel

- A. System shall include an AssureIQ PLC controller with color touchscreen HMI. Control panel shall be a single point power connection distributing power to all the equipment mounted on the skid. AssureIQ Water Treatment Controller shall include individual component detail screens, multi-level user logins, electronic equipment maintenance reminders specific to individual components, BAS integration (Modbus, BACnet), data trending for inlet temperature, water quality (post RO and loop), pump discharge pressure, UV lamp intensity, and system alarms.
 - 1. Single Point Power Connection: 208 Volt – 1 Phase. Power to:
 - a. Carbon Filter/ Water Softener
 - b. Reverse Osmosis System
 - c. Electro deionization System
 - d. Re-pressurization Pump(s)
 - e. Ultraviolet Lamp(s)

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS – GENERAL

- A. Install high purity water system according to the drawings and manufacturer's instructions. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local requirements.
- B. Provide services of a qualified manufacturer's representative to check complete installation for conformance to manufacturer's recommendations, put system into service, make all adjustments required for full conformance to design and specified requirements, and perform all demonstrations and tests.

3.2 EQUIPMENT

- A. Vendor shall furnish equipment installation instructions in the form of drawings and written instruction as part of the Operation and Maintenance Manuals. Installation of factory-assembled equipment skids, loose equipment, interconnecting piping and

accessories, control panels, interconnecting wiring, and instrumentation shall be by the Mechanical and Electrical Contractors under the Vendor's supervision.

- B. Mechanical and Electrical Contractors shall be responsible for installation of equipment base pads for equipment skids, pumps, vessels, panels, etc. Typical base pad details are provided on the Drawings.

3.3 TANK INSTALLATION

- A. Tanks shall be stored on a smooth, padded surface until installation. Care will be taken during storage to prevent flexing of the nozzles, brackets, or lugs and impacts and rolling.
- B. The Mechanical Contractor shall verify field conditions prior to installation.
- C. The Mechanical Contractor shall install the tank per the manufacturer's written instructions, this specification, and the drawings.

3.4 FILTER INSTALLATION

- A. Filter elements: The sacrificial and operational filter element sets shall be installed in the filter housings by the RO and DI water systems Vendor.
- B. All filter elements shall be shipped to the job site in the filter manufacturer's original, unopened shipping containers by the vendor just prior to installation in the filter housings.

3.5 INSTRUMENTATION AND CONTROLS INSTALLATION

- A. Electrical Contractor shall install, connect, and calibrate field-mounted instrumentation and control devices in accordance with the drawings provided by the Vendor.
- B. Panels and wiring shall be installed in accordance with applicable sections in Special Construction Divisions and Electrical Divisions.
- C. Vendor shall be responsible for installation, startup, debugging, and demonstration of system controls.

END OF SECTION

SECTION 23 05 00

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the basic requirements for all sections included in Division 15.
- B. Requirements for the following are included:
 - 1. Related work (other Contract Documents and specification sections) which must be combined with the requirements of this Section.
 - 2. Design criteria.
 - 3. Regulatory requirements.
 - 4. Delivery, storage, and handling.
 - 5. Submittals.
 - 6. Product quality, basic type, and finishes.
 - 7. Equipment identification.
 - 8. Vendor representative requirements.
 - 9. Mounting and shimming.
 - 10. Inspection.
 - 11. Safety considerations.
 - 12. Cleaning, startup, and adjustments.

1.2 DESIGN CRITERIA

- A. Supports, Anchors, and Restraints:
 - 1. General:
 - a. Provide design for supports and anchors, for equipment, and supports for conduit, piping, and ductwork when they are not shown on the Drawings.
 - b. Do not allow connections to structural framing to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
 - 2. Engineered Support Systems: Provide the following support systems with designed, detailed, and bearing the seal of a professional engineer registered in the state having jurisdiction.
 - a. Support frames, such as pipe racks or stanchions, which provide support for piping, ductwork, and equipment from below.
 - b. Equipment and support frame anchors supported from slab or structure.
- B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically suited to meet operating guarantees at the specified service conditions.
- C. The flange facing for nozzles, manways, handholes, and equipment body joints shall be correct for the type of gasket provided. Ordinary compressed sheet gaskets require only

the standard machine finish on the raised face. Smooth metal gaskets, either plain or filled, require a fine-serrated finish. Corrugated metal and spirally wound metal gaskets, either plain or filled, require a smooth finish (125 AARH or 125 rms) for proper applications. Provide ring-type joint gaskets and gasket grooves conforming to ANSI B16.20.

1.3 REGULATORY REQUIREMENTS

- A. Obtain permits and arrange inspections required by codes applicable to this Section. Submit written evidence to JACOBS that required permits, inspections, and code requirements have been secured.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Shipment:
 - 1. Prepare equipment for the specified shipment. Ship each unit or part of unit for outdoor storage for a period of at least 6 months in a manner requiring no disassembly prior to operation.
 - 2. The adequacy of the preparation for shipment provisions employed with respect to materials and application is the sole responsibility of the Contractor.
 - 3. Protect flange facings by securely fastened durable covers to prevent damage during shipment.
 - 4. Provide equipment completely free of water prior to shipment preparation.
 - 5. Give a heavy coating of rust-inhibiting compound to exposed finished and machined surfaces, including bolting. Spray or coat with a suitable strippable rust preventative on internal metal surfaces.
 - 6. Thoroughly clean bearings, bearing housings, and oil systems, including reservoirs, coolers, filters, and piping internally free of metal particles, dirt, and debris and coated with a suitable rust preventative prior to shipment.
 - 7. Provide adequate protection against mechanical damage and atmospheric corrosion in transit.
 - 8. Provide supports and rigging connections to prevent damage during transit, lifting, or unloading.
 - 9. Provide threaded connections with a pipe plug of the same material as the connections. Use Teflon tape as a thread sealant.
 - 10. Suitably tag openings that require rust preventative to indicate the type and nomenclature of the rust preventative used.
 - 11. Suitably tag equipment containing insulating oils or other fluids at openings to indicate the nature of the contents and shipping and storage precautions.
 - 12. Cap open ends of tubes (just taping is not adequate) for protection.
 - 13. Pack, securely anchor, and weather protect equipment (skid mounted when required), for the shipment method called for in the Contract. Box separate, loose, or spare parts and each part individually protected as required. Mark each individual container both inside and outside with the equipment number and service for which the parts are intended.
 - 14. Pack and ship with the equipment, one complete set of installation, operating, and maintenance instructions. This set is in addition to the sets that are to be sent directly to the Owner.

15. Include in each container a complete bill of materials identifying each part. In some instances, such as instruments, specific tagging is required.
16. Impression stamp piping connections furnished on the purchased equipment to agree with manufacturer's connection table listed on the general arrangement drawing. Tagging in lieu of stamping is only acceptable where the connections, because of size or geometry, cannot be impression stamped.

1.5 SUBMITTALS

- A. Provide the following:
 1. With the Bid:
 - a. An individual price and delivery schedule for each equipment number.
 - b. The length of time required for certification of all information, drawings, etc.
 - c. Estimated equipment weight and support requirements.
 - d. Electrical power requirements, including in-rush current, and recommended fuse size.
 - e. Utility (cooling water, air, fuel, etc.) requirements.
 - f. A list of deviations to the specified requirements.
 - g. Adequate dimensional data to permit the design of foundation, piping, and wiring connections.
 - h. Clearance required for disassembly and maintenance.
 - i. Completed contract specification datasheets.
 2. Provide the following within 4 weeks of Contract award:
 - a. Certified correct dimensional drawings of completed assembled units, which show:
 - 1) Identification data for equipment components.
 - 2) Rotation.
 - 3) Weight.
 - 4) Location of motor junction box(es).
 - 5) Piping connections identified with the size, rating, and facing indicated.
 - b. Identify auxiliary connections on the composite outline drawing as follows:
 - 1) Not furnished this order.
 - 2) Not drilled this order.
 - 3) Plugged, requires field piping by Contractor.
 - 4) Plugged, not required this order.
 - 5) Piped by manufacturer.
 - c. Reference to supplementary drawings required to complete auxiliary piping.
 3. Provide the following from the manufacturer's representative as soon as available:
 - a. A record of startup events noting problems and their resolution.
 - b. A record of set points for operational controls and devices.
 - c. Certification that the equipment has been installed as specified and in accordance with the manufacturer's requirements.

4. Submit written notice to the Owner and JACOBS that the units are ready for use by the Owner upon completion of the inspections, startup, testing, and checkout procedures by the equipment manufacturer.
- B. Review of manufacturer's drawings shall not relieve the Contractor from the responsibility for equipment performance and compliance with this Specification.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide equipment of the manufacturer's most recent standard design. Equipment designs that have not been previously used successfully in an industrial application are not acceptable.

2.2 EQUIPMENT IDENTIFICATION

- A. Provide equipment with a stainless-steel identification tag pinned in place in a readily accessible location with the following information at a minimum (when applicable):
1. Manufacturer's name.
 2. Manufacturer's model number.
 3. Date of manufacture.
 4. Design operating conditions.
 5. Design pressure and temperature.
 6. Serial number.
 7. Materials of construction.
 8. Code stamp.
 9. RPM.
- B. Electrical power requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the requirements of the equipment manufacturer.
- B. Equipment Manufacturer's Responsibility and Services:
1. Provide a manufacturer's representative for major equipment and operating systems to assist the Contractor during installation.
 2. Provide the manufacturer's representative onsite during initial startup of equipment in the presence of Owner.
 - a. Provide a prestart check of piping, valves, control devices, control panels, and equipment.
 - b. Calibrate and adjust equipment and controls for operation at the specified design conditions.

3. Upon the completion of equipment startup, provide instructional time with the Owner's personnel to review the operations and maintenance manuals and perform each step necessary for startup, shutdown, troubleshooting, and routine maintenance. Schedule the instructional time through the Owner.

3.2 MOUNTING AND SHIMMING

- A. Mount equipment as shown on the Drawings. Provisions for mounting special equipment on spring isolators and inertia bases are specified in Section 23 24 00, Vibration Isolation.
- B. Level the equipment by means of steel wedges (steel plates and steel shims). Wedge taper shall not be greater than 1/4 inch per foot. Use double wedges to provide a level-bearing surface for the equipment. Service each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Execute wedging in a manner that will prevent a change in level or springing of the baseplate when the anchor bolts are tightened.
 1. Adjust rotating equipment assemblies such that the driving units are properly aligned, plumb, and level with the driven units and interconnecting shafts and couplings.
 2. Check rotating equipment for proper alignment with dial indicators. The alignment must be within the tolerances required by the equipment manufacturer. The final alignment check shall be witnessed by Owner.
- C. After the equipment has been set in position, align, and shim to the proper elevations, grout the space between the bottom of the baseplate and the concrete foundation and/or inertia base with a poured non-shrinking grout.

3.3 INSPECTION

- A. Inspect the work to ensure the installation and workmanship is in accordance with these specifications and acceptable industry standards for the work being done.
- B. The extent of testing, whether witnessed or not, is listed in the individual data sheets. Such testing may include full and/or part load performance tests, basic mechanical spin tests, etc. It may also include various nondestructive tests as required by specified codes, including those normally required by the manufacturer's own manufacturing standards.
- C. It is a requirement of this Specification that JACOBS's inspection work be minimized by assigning to the Contractor the responsibility of furnishing the inspector with necessary material certifications, shop test data, radiographic plates, and the like necessary to verify the Contractor's compliance with the specifications for Contractor-furnished equipment.
- D. Where shop inspection is specified, no surfaces or parts are to be painted until the inspection is complete.
- E. Make materials, equipment, and workmanship available to inspection at any time by the Owner. Correct any work, materials, or equipment not in accordance with the Contract Documents.

3.4 SAFETY CONSIDERATIONS

- A. Install equipment with suitable access clearances for maintenance or removal of replaceable parts and components and with necessary unions or flanges to perform the maintenance or removal without removing the connecting appurtenances.
- B. Where equipment requiring periodic maintenance cannot be reached by normal walkways because of interference with ductwork, piping, or other obstructions, provide an alternate safe means of access. These may include construction of an overhead platform with stairway or ladder ends and safety railings or handholds or walk-through duct plenums with hinged access doors or as required to meet OSHA standards for safe maintenance procedures.

3.5 CLEANING, STARTUP, AND ADJUSTING

- A. The Contractor is responsible for proper operation of systems, minor subsystems, and services provided under this Section. Coordinate startup procedures, calibration, and system checkout with all subcontractors involved. System operational problems shall be diagnosed; correctional procedures shall be initiated with the various contractors as required to bring the system into compliance with the design and the problem then shall be rechecked to verify that the system operates normally. Bring remaining difficulties to the attention of JACOBS.
- B. Thoroughly clean parts of the installation at the completion of the work. Clean up and remove from the premises refuse material, crates, and rubbish arising from the work. Remove, clean, and reinstall all filters. Check belt-drive tensions and alignments. Lubricate motors and bearings in accordance with the manufacturer's service manuals prior to equipment startup. Provide a lubrication schedule for every item of equipment furnished under this Section. Include the type of lubricant and the application frequency.

END OF SECTION

SECTION 23 05 21

AIR FLOW MEASURING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes furnishing and installation of complete airflow control and indicating system with primary flow and pressure measuring elements, process indication meters, system controllers, transmitters and control centers of sizes, capacities, arrangements, and in locations as indicated and scheduled on Drawings and as specified. It is not intended that control specialist can provide this control through building automation system.
- B. Substitutions/Exceptions:
 - 1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.
 - 2. Deviations are permitted only if outlined in full detail. Obtain approval of those deviations, and reasons for them, will constitute acceptance.
 - 3. State options in proposal.

1.2 SUBMITTALS

- A. Refer to the submittal schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Air Monitor Corporation.
- B. Paragon Controls Incorporated.
- C. Ebtron.

2.2 MEASURING ELEMENTS

- A. Airflow Measuring Elements:
 - 1. Provide where indicated and scheduled airflow measuring elements capable of continuously monitoring fan or duct air volumetric flow rate.
 - 2. Construct airflow measuring elements of extruded aluminum or 316 stainless steel, forming two integral chambers for total and static pressure averaging, without physical presence of forward projecting sensors.
 - 3. Airflow elements not to induce pressure drop greater than 0.05-inch water column at 2,000 FPM, nor will sound level within duct be amplified by its presence in air stream.

4. Each airflow measuring element to contain multiple total and static pressure sensors, placed at equal distances (for rectangular ducts) and at concentric area centers (for circular ducts) along element length.
 5. Number of sensors on each element and quantity of elements utilized at each installation to comply with ASHRAE Standard III for duct traversing.
 6. Airflow measuring elements capable of producing steady, non-pulsating total and static pressure signals, with accuracy within ± 2 percent of actual flow.
 7. Airflow measuring elements complete with necessary mounting hardware, sealing gaskets, nuts and washers, and required connection fittings for connection to tubing.
- B. Installation Considerations:
1. Install primary elements in accordance with manufacturer's published requirements, and with ASME guidelines affecting non-standard approach conditions. These elements serve as primary signals for airflow systems; therefore, verify location and installation, to ensure that accurate primary signals are obtained.
 2. Where elements are installed in insulated ducts, configure primary elements sensing ports to match inside dimensions of duct. Match size elements to match ductwork external dimensions.

2.3 INSTRUMENT PERFORMANCE

- A. Airflow control systems to include transmitters, transducers, controllers, relays, and indication required to maintain airflow conditions as described in Sequence of Operation.
- B. Interconnect control devices to perform required functions and operate in required sequence.
- C. Control components capable of receiving, transmitting and controlling system with low velocity and static pressure input signals inherent during system turn-down or set-back modes of operation.
- D. Control instrumentation and devices of process control quality with operating features described herein.
- E. Provide instruments/components which have performance capabilities (span, accuracy) to comply with requirements of this Section.
- F. Transmitters:
1. Capable of receiving pneumatic signals from their respective primary measuring elements and producing electronic output signal linear to system static pressure and velocity pressure.
 2. Performance:
 - a. Span: Not greater than twice that of system design or three times design for space pressurization control.
 - b. Accuracy: ± 0.5 percent of span.
 - c. Hysteresis and Dead Band: Non-detectable.
 - d. Linearity: ± 0.5 percent of span.

- e. Repeatability: Within 0.03 percent of output.
- f. Response: Less than 0.05 second for full span input.
- g. Temperature Effects: Less than +0.03 percent FS/°F.
- h. Overpressure: 10 psig proof and 50 psig burst pressure.

PART 3 - EXECUTION

3.1 INSTALLATION, SYSTEM CALIBRATION, STARTUP, AND SERVICE

- A. Provide external interconnecting control or pressure signal tubing, wiring, and uninterrupted 24V ac power supply.
- B. In conjunction with system startup, instruct operating personnel on proper operation of airflow control system.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
23 05 21-03	Electrical and pneumatic termination points, tube and wire sizes, and power requirements.	X	Prior to delivery

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing adjusting and balancing of air systems.
 - 2. Measurement of final operating condition of HVAC systems.
 - 3. Sound measurement of equipment operating conditions.
 - 4. Vibration measurement of equipment operating conditions.

1.2 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms, forms prepared following ASHRAE 111, NEBB Report forms, or forms containing information indicated in Schedules.
- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or a Copy of NEBB Certificate of Conformance Certification.
- F. Submit draft copies of report for review prior to final acceptance of Project.

- G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of flow measuring stations, balancing valves and rough setting.
- B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, or ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years experience certified by AABC or Certified by NEBB.
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer, a NEBB Certified Testing, Balancing and Adjusting Supervisor or a registered professional engineer experienced in performance of this Work and licensed in State of Texas.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed, and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Proper strainer baskets are clean and in place or in normal position.
 - 13. Service and balancing valves are open.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

- A. Section 01 77 10 – Closeout Procedures: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.

- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross-sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance Office area variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.6 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Air Coils.
 - 2. Fan Coil Units.
 - 3. Air Handling Units.
 - 4. Fans.
 - 5. Air Filters.
 - 6. Air Terminal Units.
 - 7. Air Inlets and Outlets.
 - 8. Laboratory supply and exhaust valves.
- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer

- c. Model number
- d. Serial number
- e. Range
- f. Calibration date
- 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
- 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
- 6. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual
 - l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Air pressure drop, design and actual
- 7. Electric Duct Heater:
 - a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Design kW
 - f. Number of stages
 - g. Phase, voltage, amperage
 - h. Test voltage (each phase)
 - i. Test amperage (each phase)
 - j. Air flow, specified and actual
 - k. Temperature rise, specified and actual

8. Air Moving Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
9. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
10. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
11. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity

- g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
12. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
13. Air Monitoring Station Data:
- a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
14. Flow Measuring Station:
- a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Design Flow rate
 - h. Design pressure drop
 - i. Actual/final pressure drop
 - j. Actual/final flow rate
 - k. Station calibrated setting
15. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow

- i. Maximum design air flow
- j. Maximum actual air flow
- k. Inlet static pressure
- 16. Laboratory Valve Data:
 - a. Manufacturer
 - b. Type, constant, variable
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
- 17. Fume Hood Data:
 - a. Manufacturer
 - b. Type, constant, variable
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Inlet static pressure
 - k. Sash position
- 18. Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
- 19. Sound Level Report:
 - a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
- 20. Vibration Test:
 - a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (when applicable)

- 4) Motor bearing, drive end
- 5) Motor bearing, opposite end
- 6) Casing (bottom or top)
- 7) Casing (side)
- 8) Duct after flexible connection (discharge)
- 9) Duct after flexible connection (suction)
- b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
- c. Normally acceptable readings, velocity and acceleration
- d. Unusual conditions at time of test
- e. Vibration source (when non-complying)

END OF SECTION

SECTION 23 09 13

LABORATORY AIRFLOW CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the design, manufacture, testing, calibration, and delivery, and installation of the laboratory airflow control system, complete with accessories and:
 - 1. Sash sensors.
 - 2. Fume hood monitor/controllers.
 - 3. Constant volume air valves.
 - 4. Variable air volume air valves.
 - 5. Variable air volume airflow controllers.
 - 6. Laboratory airflow control panel.
- B. Substitutions/Exceptions:
 - 1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.
 - 2. Deviations are permitted only if outlined in full detail. Written approval of those deviations, and reasons for them, will constitute acceptance.
- C. Compliance: Mechanical design in compliance with this Section is responsibility of the manufacturer.

1.2 REFERENCES

- A. Industry Standards: Design and fabricate in accordance with following codes and standards: Use current adopted edition.
 - 1. ANSI/AIHA Z9.5-92.
 - 2. NFPA 45.
 - 3. OSHA 29 CFR 1910.1450.
- B. Conflicting Requirements: If Section requires compliance with two or more industry standards which establish different or conflicting requirements, obtain approval before proceeding with affected operations.

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of the submittal requirements for this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and handle equipment as follows:
 - 1. Use methods which prevent damage, deterioration, and other loss during shipping and temporary on-site storage.

2. Plug, cap, or cover exposed openings with plywood or other suitable material.
 3. Provide instructions for proper unpacking.
- B. Deliver loose parts in boxed plywood containers and ship as a unit with equipment.
- C. Cleaning prior to shipping:
1. Perform final cleaning of internal and external surfaces after manufacturing and testing operations have been completed.
 2. Upon final cleaning enclose and seal laboratory airflow control system components in plastic wrapping materials to minimize infiltration of dirt and contamination during transit.
- D. Identify shipping boxes by order number, Project name, Project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix copy of completed packing list to each separate shipping package.
- E. Inspect equipment when delivered to ensure equipment is undamaged and complies with specified requirements.
- F. Store equipment in a manner which facilitates inspection and measurement of quantity. Protect stored products from loss by exposure to rain, wind-driven dust, and other similar phenomena.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

- A. Comply with requirements, tests, inspections, reports, documentation, and specified approvals and standards implemented by this Section. Make available on request copy of part of manufacturer's quality assurance records. Tests, inspections, reports, and documentation are subject to inspection.
- B. Provide notification not less than 10 working days prior to start of fabrication.
- C. Maintain records of inspections and tests. Indicate nature and number of deficiencies found, quantities approved and rejected, and nature of corrective actions taken. On request, supply copies of inspection and test data prior to or at time of shipment.
- D. Provide notification not less than 5 working days prior to conducting inspection or testing required by this Section.

2.2 PERFORMANCE CRITERIA

- A. Speed of response less than 1 second without undue oscillation. Response time is defined as amount of time required for airflow control valve to reach 90 percent of its final value when commanded.

- B. Overall system having control stability of less than ± 5 percent overshoot/undershoot in order to maintain room pressurization control. Measure stability in conjunction with speed of response of less than 1 second.
- C. Provide air valves with accuracy of ± 5 percent of set point over turn down range of at least 10 to 1. Provide multiple sequenced valves where individual valves cannot maintain specified accuracy over required control range.
- D. Provide air valves that are insensitive to inlet and outlet conditions with respect to accuracy.
- E. Provide individual face velocity controllers that directly measure area of fume hood sash opening and proportionally control hood's exhaust airflow in variable volume mode to maintain constant face velocity over minimum range of 20 percent to 100 percent of full sash opening.
- F. Use volumetric offset control to maintain room pressurization. System to respond and maintain room pressurization within 1 second of change in room/system conditions.
- G. Provide fume hood monitor/controller with following:
 - 1. Audible alarm and red warning light.
 - 2. Silence switch.
 - 3. Press to test circuit.
 - 4. Pressure sensors to verify adequate static pressure conditions.
 - 5. Dry contact to indicate low airflow condition.
 - 6. Built-in time delay.
 - 7. LCD display to indicate average face velocity in feet per second.

2.3 EQUIPMENT

- A. Sash Sensor: Provide vertical sash sensor to measure height of each vertically moving fume hood sash.
- B. Fume Hood Monitor/Controller:
 - 1. Provide fume hood monitor to receive sash sensor output signal and to generate exhaust airflow control signal for appropriate volume control device to provide constant yet adaptive face velocity. Airflow at fume hood to vary in linear manner between adjustable minimum and maximum flow set points to maintain constant face velocity throughout this range. Set minimum volume to ensure flow through fume hood even with sash totally closed.
 - 2. Provide monitor/controller with following audible and visual indications:
 - a. Low flow alarm triggered by differential pressure sensor in duct upon sensing low static pressure condition.
 - b. Emergency exhaust push button/alarm to allow operator override during emergency exhaust conditions.
 - c. Energy waste alarm triggered by adjustable light level sensor to indicate fume hood sash has been left open after lights have been turned off.
 - d. Digital display indicating face velocity in CFM.

3. Fume hood controller to interface to the included fume hood monitor mounted on the face of the fume hood. The fume hood monitor shall include an LCD screen capable of displaying all the fume hood parameters including face velocity, alarm status, alarm reason, valve airflow, valve differential pressure, and all hood configuration variables.
 4. Provide fume hood controller to include the ability for the operator to select from the following modes:
 - a. Normal/in-use (adjustable constant face velocity set point)
 - b. Setback (adjustable constant face velocity set point)
 - c. Emergency override (maximum hood air flow)
 - d. Off/Shutdown (fume hood shut down flow, all alarms disabled)
 5. Fume hood controller to be fully configurable in the field from the fume hood monitor without having to access hardware in the ceiling.
 6. Fume hood controller to include an operator presence sensor on each fume hood. When no operator is present at the hood for an adjustable time interval, the fume hood shall automatically adjust to a lower average face velocity setpoint.
- C. Airflow Control Valve – General:
1. Airflow control valve of Venturi valve control type.
 2. Exhaust air system venturi valve of low-pressure device capable of operating at static pressure of 0.3 to 3 inches WC.
 3. Supply air system venturi valve of medium pressure device capable of operating at static pressure of 0.6 to 3 inches WC.
 4. Valve with integral pressure independent assembly to respond and maintain specific airflow within 1 second of change in duct static pressure irrespective of magnitude of pressure and/or flow change or quantity of airflow controllers on manifolded system.
 5. Provide airflow accuracy within ± 5 percent of reading (not full scale) over airflow turndown range of not less than 10 to 1.
 6. Base valve construction on service end:
 - a. Provide 14-gauge aluminum (valve body) and 16-gauge aluminum (valve cone) for makeup air and general exhaust air valves. Provide PTFE Teflon coated 316 stainless steel center shaft. Provide 316L series stainless steel for assembly's shaft, pivot arm, shaft support brackets, and internal mounting hardware. Provide spring-grade stainless steel pressure independent springs. Provide Teflon shaft bearing surfaces. Provide insulated supply valves with $\frac{3}{4}$ inch flexible closed-cell polyethylene insulation with a flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 - b. Provide baked on, corrosion-resistant phenolic coating for fume hood exhaust valve. Provide Teflon coated 316 stainless steel center shaft. Provide 316 stainless steel center shaft support brackets, and 316 stainless steel pivot arm and internal mounting link. Provide spring-grade stainless steel pressure independent springs. Provide stainless steel internal nuts, bolts, and rivets. Provide PTFE Teflon surfaces on all shaft bearings.
 7. Factory-mount high speed UL 916 electronic actuator to valve. Loss of main power to position exhaust valves to fail open to maximum scheduled design flow

and supply valves to fail to minimum scheduled design flow. Constant volume valves do not require actuators.

- D. Variable Volume Airflow Controller: Provide valve airflow controller with electronic-based control to regulate air volume linearly proportional to 0- to 10-volt electronic control signal from fume hood monitor/controller or laboratory control panel. Valve to generate 0- to 10-volt feedback signal linearly proportional to its airflow for internal volume control or airflow tracking control where required.
- E. Laboratory Airflow Control Panel:
 - 1. Provide laboratory control panel to control airflow balance of laboratory where required on Drawings.
 - 2. Control panel of digital or electronic design with analog or digital signal inputs and outputs. Inputs to accept signals proportional to fume hood, canopy and laboratory supply flows. Output signals to control supply valves and general exhaust valves.
 - 3. Control panel to maintain constant, adjustable offset between sum of room's total exhaust and supply air volumes. Offset independent of exhaust volume magnitude and represent volume of air that will enter or exit room.
- F. Laboratory Supply Air Valve Electric Heating Coil:
 - 1. Provide minimum 20-gauge, 0.038-inch galvanized steel electric coil casing.
 - 2. Provide open wire nickel chrome construction, supported by ceramic insulator, heating elements.
 - 3. Provide NEMA 250, Type 1 control panel enclosure with hinged access door for access to all controls and safety devices.
 - 4. Provide primary automatic reset thermal cutout, secondary manual reset thermal cutout, and differential pressure airflow switch for proof of airflow for electric coil.
 - 5. Provide silicon-controlled rectifier (SCR) controller with Analog Control 0-10 VDC electric coil.
 - 6. Provide ¾ inch fiber-free lined insulation on electric coil housing.
 - 7. Provide non-fused door interlocking disconnect switch.
- G. Room Pressure Monitoring Sensor:
 - 1. Provide a room pressure sensor in each lab.
 - 2. Monitor room pressure at all times with reference to the adjacent space.
 - 3. The room pressure reading to be available to the BMS system.

2.4 INTEGRATION INTO BUILDING MANAGEMENT SYSTEM

- A. The Lab Airflow Control System to be capable of integration to building management system (BMS).
- B. Employ room-level network to ensure that loss of BMS communication does not affect the room airflow control.

2.5 FABRICATION/SHOP ASSEMBLY

- A. Completely shop assemble parts and check for proper fit and alignment before shipment.
- B. Tag equipment per attached Tag Data Sheet. Where equipment fabrication is of alloys not compatible with stainless steel, fabricate tag from equipment material.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install system components per manufacturer's recommendations.
- B. Commissioning: Laboratory airflow control system manufacturer to provide factory-trained technician to commission system components and assist testing and balancing in verifying and modifying air flows and adjusting system set points. Laboratory airflow control manufacturer is responsible for commissioning entire system, including verifying pneumatic, control wiring, and duct connections and taking appropriate minor remedial action.
- C. Training: Upon successful commissioning, factory-trained technician to provide general system overview to designated representatives and provide instruction in system operation, diagnostics, and troubleshooting. Duration of instruction period not less than 8 hours, during normal working hours, excluding travel time.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
23 09 13-01	Complete descriptive information including product catalog data, operating characteristics, configuration, component descriptions, installation requirements, electrical service requirements, dimensions, and materials	X	Prior to delivery
23 09 13-02	Detailed list of special tools and devices required to install, adjust, repair, test, or operate equipment. Identify and price separately items which are not provided with equipment.	X	With operations and maintenance manuals
23 09 13-03	Air valve calibration reports with certified record.	X	With operations and maintenance manuals

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- B. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network, and (at the owner's discretion) over the Internet. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.
- C. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends and alarms.
- D. Building control system shall have capability to connect to City of Arlington Schneider StruxurWare Front End System.

1.2 APPROVED CONTROL SYSTEM MANUFACTURERS

- A. Use control system hardware and software that meet the requirements of this specification.
- B. Codes and Standards:
 - 1. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
 - a. National Electric Code (NEC)
 - b. International Building Code (IBC)
 - c. International Mechanical Code (IMC)
 - d. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.3 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
 - 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 - 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 - 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

**TABLE-1
REPORTING ACCURACY**

Measured Variable	Reported Accuracy
Space Temperature	±1°F
Ducted Air	±1°F
Outside Air	±2°F
Dew Point	±3°F
Water Temperature	±1°F
Delta-T	±0.25°F
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Water Pressure	±2% of full scale (see Note 2)
Electrical	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10%–100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

**TABLE 2
CONTROL STABILITY AND ACCURACY**

Controlled Variable	Control Accuracy	Range of Medium

TABLE 2 CONTROL STABILITY AND ACCURACY		
Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g. ±0.01 in. w.g.	0–6 in. w.g. -0.1 to 0.1 in. w.g.
Airflow	±10% of full scale	
Space Temperature	±2.0°F	
Duct Temperature	±3°F	
Humidity	±5% RH	
Fluid Pressure	±1.5 psi ±1.0 in. w.g.	1–150 psi 0–50 in. w.g. differential

1.4 SUBMITTALS

- A. Product Data and Shop Drawings: Meet requirements of Submittal Procedures on Shop Drawings, Product Data, and Samples. In addition, the contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2008 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:
1. DDC System Hardware:
 - a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
 - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - 1) Direct digital controllers (controller panels)
 - 2) Transducers and transmitters
 - 3) Sensors (including accuracy data)
 - 4) Actuators
 - 5) Valves
 - 6) Relays and switches
 - 7) Control panels
 - 8) Power supplies
 - 9) Batteries
 - 10) Operator interface equipment
 - 11) Wiring
 - c. Wiring diagrams and layouts for each control panel. Show termination numbers.

- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
 - a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - 1) Central Processing Unit (CPU) or web server
 - 2) Monitors
 - 3) Keyboards
 - 4) Power supplies
 - 5) Battery backups
 - 6) Interface equipment between CPU or server and control panels
 - 7) Operating System software
 - 8) Operator interface software
 - 9) Color graphic software
 - 10) Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems:
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

- B. Schedules:
1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a. Intended sequence of work items
 - b. Start date of each work item
 - c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times
 - e. Milestones indicating possible restraints on work by other trades or situations
 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.
- C. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents of the documents shall be submitted for approval prior to final completion and shall include:
1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2011 (or newer) compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and as 11" x 17" prints.
 2. Testing and Commissioning Reports and Checklists.
 3. Operation and Maintenance (O&M) Manual.
 4. As-built versions of submittal product data.
 5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 9. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 10. Graphic files, programs, and database on magnetic or optical media.
 11. List of recommended spare parts with part numbers and suppliers.
 12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 14. Licenses, guarantees, and warranty documents for equipment and systems.
 15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet

Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.5 WARRANTY

- A. Warrant work as follows:
 - 1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
 - 2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up.
 - 3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
 - 4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. Do not install updates or upgrades without Owner's written authorization.

1.6 MAINTENANCE SERVICE

- A. Section 01 77 10 – Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of control systems for one year from Date of Substantial Completion.
- C. Furnish two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.
- D. Examine unit components bi-monthly. Clean, adjust, and lubricate equipment.
- E. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- F. Perform work without removing units from service during building normal occupied hours.
- G. Provide emergency call back service during working hours for this maintenance period.
- H. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- I. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- J. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.7 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

1.8 DEFINITIONS

TERM	DEFINITION
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Spare parts shall be available for at least five years after completion of this contract.

- B. Manufacturers:
 - 1. Automated Logic
 - 2. Johnson Controls.
 - 3. Schneider Electric
 - 4. The Trane Company.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Interface to the Laboratory Airflow Control system macro-server gateway.
- C. Building control system shall have capability to connect to City of Arlington Schneider StruxurWare Front End System.
- D. Install new wiring and network devices as required to provide a complete and workable control network.
- E. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- F. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified on the construction drawings. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- G. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- H. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3 OPERATOR INTERFACE

- A. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.
- B. Operator Interface: Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.

- C. Communication: Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- D. Hardware: Each workstation or web server shall consist of the following:
1. Computer: Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
 - a. The hard disk shall have sufficient memory to store:
 - 1) All required operator workstation software.
 - 2) A DDC database at least twice the size of the delivered system database.
 - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - 1) Dual or Quad Core Processor
 - 2) 6 GB RAM
 - 3) 500 GB hard disk providing data at 3.0 Gb/sec
 - 4) 16x DVD-RW drive
 - 5) Serial, parallel, and network communication ports and cables as required for proper DDC system operation
- E. System Software:
1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows7, Microsoft Vista, Microsoft Windows XP Pro, Windows Server 2003 or 2008.
 2. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for the chilled water and airside systems, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
 - a. Functionality: Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. Animation: Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication: Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format: Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Adobe Flash).
 3. Custom Graphics: Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be

a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.

4. Graphics Library: Furnish a complete library of standard HVAC equipment graphics such as chillers, air handlers, terminals, fan coils, laboratory valves, and fume hoods. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- F. System Applications: System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration: Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download: Operators shall be able to download memory from the system database to each controller.
 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 4. On-Line Help: Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Security: Each operator shall be required to log on to the system with username and password in order to view, edit, add, or delete data.
 - a. Operator Access. The username and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
 6. System Diagnostics: The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
 7. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section Sequences of Operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 8. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms.
 9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

10. Alarm and Event log: Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms and archive closed alarms to the workstation or web server hard disk.
 11. Trend Logs: The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section Sequences of Operation. Trends shall be BACnet trend objects.
 12. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
 13. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 14. Standard Reports: Furnish the following standard system reports:
 - a. Objects: System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary: Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs: System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.
 - 3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
- G. Workstation Application Editors: Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller: Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 2. Scheduling: An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 3. Custom Application Programming: Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language: Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."

- b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/paste and find.
 - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results.
 - e. The programming language shall support conditional statements (IF/THEN/ELSE/ ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. The programming language shall support floating-point arithmetic using the following operators: +, -, $\div$, $\times$, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
 - g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/ THEN comparisons, calculations, etc.
 - h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
 - i. The programming language shall have predefined variables representing the status and results of the system software and shall be able to enable, disable, and change the setpoints of the system software described below.
- H. Portable Operator's Terminal: Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.4 CONTROLLER SOFTWARE

- A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. Scheduling: Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 1. Weekly Schedule: Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - 3. Holiday Schedules: Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.

- C. System Coordination: Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- D. Binary Alarms: Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- E. Analog Alarms: Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
- F. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
- G. Remote Communication: System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- H. Sequencing: Application software shall sequence chillers, and pumps as specified in Section Sequences of Operation.
- I. PID Control: System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
- J. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- K. Anti-Short Cycling: All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- L. On and Off Control with Differential: Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- M. Runtime Totalization: Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section Sequence of Operations.

2.5 CONTROLLERS

- A. General: Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section Article System Performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet:

1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Sensors (SSs): Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
5. BACnet Communication:
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication:

1. Service Port: Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management: BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing: Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation: Each piece of equipment specified shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

D. Environment: Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.

2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.
- E. Keypad: Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- F. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.
- G. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- H. Memory:
 1. Controller memory shall support operating system, database, and programming requirements.
 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
- J. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 INPUT AND OUTPUT INTERFACE

- A. General: Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection: All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs: Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.

- E. Analog Inputs: Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs: Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs: Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. System Object Capacity: The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.7 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 32°F and 120°F. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering:
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz.

2.8 AUXILIARY CONTROL DEVICES

- A. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follows:
1. Type: Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - b. Other modulating dampers shall be opposed blade.
 - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
 2. Frame: Damper frames shall be 13-gauge galvanized steel channel or $\frac{1}{8}$ in. extruded aluminum with reinforced corner bracing.
 3. Blades: Damper blades shall not exceed 8 in. in width or 48 in. in length. Blades shall be suitable for medium velocity 2000 fpm performance. Blades shall be not less than 16 gauge.
 4. Shaft Bearings: Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
 5. Seals: Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per ft² at 4 in. w.g. differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 1500 fpm.
 6. Sections: Individual damper sections shall not exceed 48 in. $\times$ 60 in. Each section shall have at least one damper actuator.
 7. Modulating dampers shall provide a linear flow characteristic where possible.
 8. Linkages: Dampers shall have exposed linkages.
- B. Electric Damper Actuators:
1. Stall Protection: Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 2. Spring-return Mechanism: Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
 3. Signal and Range: Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications.)
 4. Wiring: 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 5. Manual Positioning: Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 60 in.-lb torque capacity shall have a manual crank.
- C. Temperature Sensors:
1. Type: Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
 2. Duct Sensors: Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 ft in length per 10 ft² of duct cross-section.
 3. Immersion Sensors: Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 4. Space Sensors: Space sensors shall have setpoint adjustment, override switch, display, and communication port.
 5. Differential Sensors: Provide matched sensors for differential temperature measurement.

- D. Humidity Sensors:
1. Duct and room sensors shall have a sensing range of 20%–80%.
 2. Duct sensors shall have a sampling chamber.
 3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°F–170°F.
 4. Humidity sensors shall not drift more than 1% of full scale annually.
- E. Relays:
1. Control Relays: Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- F. Override Timers:
1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6-hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- G. Current Transmitters:
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500-ohm maximum burden.
 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- H. Current Transformers:
1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- I. Voltage Transmitters:
1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
 2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500-ohm maximum burden.
 3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.
- J. Voltage Transformers:
1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

2. Transformers shall be suitable for ambient temperatures of 40°F–130°F and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- K. Current Switches:
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- L. Pressure Transducers:
1. Transducers shall have linear output signal and field-adjustable zero and span.
 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.
- M. Differential Pressure Switches: Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- N. Local Control Panels:
1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
 2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.9 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 200°F minimum service.

2.10 FIBER OPTIC CABLE SYSTEM

- A. Optical Cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- B. Connectors: Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others, the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by and at the expense of the contractor.

3.2 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site:
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Test and Balance:
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- C. Life Safety:
 - 1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section Sequences of Operation.

- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
1. All communication media and equipment shall be provided as specified in Section 23 09 23 - Article Communication.
 2. Each supplier of a control's product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section Sequences of Operation.
 3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- B. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 WIRING

- A. Control and interlock wiring and installation shall comply with the national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of this section differ from Division 26, Division 26 shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

- C. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- D. All wiring in mechanical, electrical, or service rooms – or where subject to All control and interlock wiring shall comply with national and local electrical codes, mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- E. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- F. Do not install wiring in raceway containing tubing.
- G. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 ft intervals.
- H. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- I. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- J. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- K. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- L. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- N. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- O. Include one pull string in each raceway 1 in. or larger.
- P. Use color-coded conductors throughout with conductors of different colors.
- Q. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- R. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 in. from high-temperature equipment (e.g. steam pipes or flues).

- S. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- T. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- U. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- V. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- W. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- X. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

- J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 2. The maximum length of an MS/TP segment is 4000 ft with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 4. An MS/TP EIA-485 network shall have no T connections.

3.8 FIBER OPTIC CABLE

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.9 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 ft of sensing element for each 1 ft² of coil area.
- G. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- I. Differential Air Static Pressure:
1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the height-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- J. Smoke detectors, freeze stats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.10 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic:
 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2 in. of termination with control system address or termination number.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.

- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- E. Identify room sensors related to terminal boxes or valves with nameplates.
- F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- G. Identifiers shall match record documents.

3.13 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Section 23 09 23 (Sequences of Operation).

3.14 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming: Name points as shown on the equipment points list provided with each sequence of operation. See construction drawings. If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 23 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming:
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be modular and structured
 - 3) Must be commented
 - b. Graphic-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be documented
 - c. Parameter-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be documented.
- D. Operator Interface:
 - 1. Standard Graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air

handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23 09 23.

2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
 1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
 7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration:
 1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
 2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of

- this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
 4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
 5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
 6. Demonstrate compliance with Part 1, "System Performance."
 7. Demonstrate compliance with sequences of operation through all modes of operation.
 8. Demonstrate complete operation of operator interface.
 9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
 10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.17 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.18 TRAINING

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives.
 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals
 2. Advanced Operators:
 - a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures

- k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.19 SEQUENCES OF OPERATION

- A. See drawings.

3.20 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure $\frac{1}{4}$ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.

- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- J. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.21 DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.22 CONTROLS COMMUNICATION PROTOCOL

- A. General: The electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.
- B. Distributed Processing: The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity: The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment: The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°F to 140°F.
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 120°F.
- F. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- G. Memory: The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power: Controller shall be able to operate at 90% to 110% of nominal voltage rating.

- I. Transformer: Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.23 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
- B. VERIFY OPERATION OF THE INTEGRATED SYSTEM.

APPENDIX A: Glossary of Terms

Terms used within the Specification Text:

- **Advanced Application Controller (AAC):**

A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- **Application Specific Controller (ASC):**

A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- **BACnet/IP:**

An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- **BACnet MS/TP:**

An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- **BACnet over ARCNET:**

An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- **Building Controller (BC):**

A fully programmable control module, which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically, this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- **Direct Digital Control (DDC):**

A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- **PICS - Protocol Implementation Conformance Statement:**

A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- **Smart Actuator (SA):**

An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- **Smart Sensor (SS):**

A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- **Web services:**

Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

Terms used within the Sequences of Operation:

- **adj.**

Adjustable by the end user, through the supplied user interface.

- **AI, AO, etc. (Column Headings on Points List)**

AI = Analog Input. A physical input to the control module.

AO = Analog Output. A physical output from the control module.

AV = Analog Value. An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.

BI = Binary Input. A physical input to the control module.

BO = Binary Output. A physical output from the control module.

BV = Binary Value. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.

Loop = A control loop. Most commonly a PID control loop. Typically, a control loop will include a setpoint, an input which is compared to the setpoint, and an output which controls some action based upon the difference between the input and the setpoint. A PID control loop will also include gains for the proportional, integral, and derivative response as well as an interval which controls how frequently the control loop updates its output. These gains may be adjustable by the end user for control loop "tuning," but in self-tuning control loops or loops which have been optimized for a specific application the gains may not be adjustable.

Sched = Schedule. The control algorithm for this equipment shall include a user editable schedule.

Trend. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)

Alarm. The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

NOTE: If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- **KW Demand Limiting: ***

An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.

- **Occupant Override Switch, or Timed Local Override:**

A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

When the override time expires, the zone returns to its unoccupied state.

- **Occupant Setpoint Adjustment:**

A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically, the user interface for this function is built into the zone sensor.

- **Optimal Start-Up: ***

A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

A distributed system must use Run on Request with Optimal Start. (See below.)

- **Requested, or Run on Request: ***

A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.

The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- **Trim and Respond, or Setpoint Optimization: ***

A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.

Contracting Terms:

- **Furnished or Provided:**

The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

- **Install or Installed:**

The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

- **Interface:**

The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

- **Integrate:**

The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

APPENDIX B: Abbreviations

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning
ACU - Air Conditioning Unit
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
AUTO - Automatic
AUX - Auxiliary
BI - Binary Input
BO - Binary Output
C - Common
CHW - Chilled Water
CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
COND - Condenser
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA - Discharge Air
EA - Exhaust Air
EF - Exhaust Fan
EVAP - Evaporators
FCU - Fan Coil Unit
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HTEX - Heat Exchanger
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
MAX - Maximum
MIN - Minimum
MISC - Miscellaneous
NC - Normally Closed
NO - Normally Open
OA - Outdoor Air
PIU - Powered Induction Unit
RA - Return Air
RF - Return Fan
RH - Relative Humidity
RTU - Roof-top Unit
SA - Supply Air
SF - Supply Fan
SP - Static Pressure

TEMP - Temperature
UH - Unit Heater
UV - Unit Ventilator
VAV - Variable Air Volume
VVTU - Variable Volume Terminal Unit
W/ - with
W/O - without
WSHP - Water Source Heat Pump

END OF SECTION

SECTION 23 09 23.16

GAS INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes the Following Gas Instruments:
 - 1. Carbon-dioxide sensors and transmitters.
 - 2. Single-point oxygen monitoring system.
 - 3. Carbon-monoxide monitoring system.

1.3 DEFINITIONS

- A. NDIR: Nondispersive infrared.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 2. Installation instructions, including factor affecting performance.
 - 3. Product description with complete technical data, performance curves, product specification sheets.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.
- C. Samples: For each exposed product installed in finished space.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which wall-mounted instruments located in finished space are shown and coordinated with each other, showing relationship to light switches, fire alarm devices, and other installed devices using input from installers of the items involved.

- B. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gas instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 CARBON-DIOXIDE SENSORS AND TRANSMITTERS

- A. Manufacturers:
 - 1. ACME Engineering Products, Inc
 - 2. Ebtron, Inc.
 - 3. Rel-Tek Corporation
 - 4. TSI incorporated
 - 5. Vulcain, Inc.
- B. Description:
 - 1. NDIR technology or equivalent technology providing long-term stability and reliability.
 - 2. Two-wire, 4-20 mA output signal, linearized to carbon-dioxide concentration in ppm.
- C. Construction:
 - 1. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 1 enclosure for wall-mounted space applications and NEMA 250, Type 4 for duct-mounted applications.
 - 2. Equip with digital display for continuous indication of carbon-dioxide concentration.
- D. Performance:
 - 1. Measurement Range: Zero to 2000 ppm.
 - 2. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
 - 3. Repeatability: Within 1 percent of full scale.
 - 4. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
 - 5. Long-Term Stability: Within 5 percent of full scale after more than five years.
 - 6. Response Time: Within 60 seconds.
 - 7. Warm-up Time: Within five minutes.
- E. Provide calibration kit. Turn over to Owner at start of warranty period.

2.2 SINGLE-POINT OXYGEN MONITORING SYSTEM

- A. Manufacturers:
 - 1. ACME Engineering Products, Inc
 - 2. Ebtron, Inc.
 - 3. Rel-Tek Corporation

4. TSI incorporated
 5. Vulcain, Inc.
- B. This article is intended for single-point continuous monitoring and can be used as a guide for other gases. See manufacturers' product literature. Where monitoring of multiple sample points of same gas is required, consider a centralized system capable of monitoring multiple points from a single sensor suite. See "Multipoint Carbon-Monoxide Monitoring System" Article.
- C. Description:
1. System shall measure and display a single gas concentration, provide local audio and visual alarms when preset limits are exceeded, and send output signals of gas concentration and detected alarms.
 2. System shall require no periodic maintenance other than periodic checking of sensor response to a known concentration of gas.
 3. System shall be designed to provide for installation, setup, and start-up from outside of unit enclosure without need to open the enclosure door.
 4. System shall be factory calibrated and ready for operation after installation.
 5. Monitor shall be internally wired to accommodate a single-point field power connection.
- D. Performance:
1. Range: Full scale, zero to 25 percent oxygen.
 2. Zero Drift: Within 1 percent per year.
 3. Span Drift: Within 10 percent per year.
 4. Repeatability: Within 1 percent of full scale.
 5. Linearity: Within 2 percent of full scale.
 6. Step Change Response Time: Within 12 seconds.
- E. Enclosure:
1. NEMA 250, Type 4X.
 2. Access to the inside of enclosure, as well as to controller, display, and wiring connections, shall be through full-length door on front of enclosure.
 3. Door with shatterproof window sized to provide viewing of visual display and indicator lights.
 4. Equip enclosure with mounting brackets for the purpose of attaching the unit to a flat surface.
 5. Provide door with key lock access to inside enclosure.
- F. Controller:
1. Password-protected access through full-function keypad.
 2. Set:
 - a. Real-time clock.
 - b. Alarm levels.
 - c. Change span-gas values.
 - d. Display date of last calibration.
 - e. Display minimum, maximum, and average gas values.
 - f. Change address, future calibration time, and date.
 3. Automatic return-to-normal-operation feature after calibration.
 4. Date stamps last successful calibration.
 5. Time and date stamps events.

6. Selectable lockout of output signals during calibration.
 7. Logs minimum, maximum, and average gas concentrations over selected time intervals.
- G. Visual Display:
1. Four-digit LED or backlight LCD display visible from front face of enclosure.
 2. Value displayed shall be a direct reading of gas concentration.
 3. Displays system status indicators.
 4. Visual Alarm Indication:
 - a. Three separate alarm levels: Caution, Warning, and Alarm.
 - b. Separate strobes for Warning and Alarm conditions. Externally mount the two strobes on top of enclosure.
 5. Indication of sensor nearing end of its useful life based on the sensor output, not on the time the sensor was in service.
 6. Displays average, minimum, and maximum gas concentrations of the sensor over selected time.
 7. Malfunction Indication Alarm: Displays a separate unique character when an over range or under range condition exists, a sensor signal sensor is lost, or a set-point error or memory failure occurs.
- H. Audible Alarm:
1. Provides an audible horn when an alarm condition occurs.
 2. Horn shall be rated for 95 dB with selectable output tones.
 3. Mount horn inside or on exterior of enclosure.
 4. Activate horn through a horn relay. Horn relay shall be form "A" contacts and set as normally open and common.
- I. Operator Interface:
1. Door Audible Alarm Acknowledge Switch:
 - a. Push-button switch located on front door shall silence audible alarm.
 - b. Switch shall reset latched alarms if normal gas conditions exist. Visual alarms shall remain on as long as alarms are exceeded.
 2. Operating Modes and Parameters Selection: Selections listed shall be accomplished by the use of switches, jumpers, or remote control not involving the use of tools.
 - a. Display range value.
 - b. Latching or non-latching mode for the alarm set points.
 - c. Upscale or downscale acting alarms.
- J. Output Signal:
1. Relays:
 - a. Provide one relay for each set-point level for each of the three alarm levels.
 - b. Provide one relay for fault conditions.
 - c. Alarm and fault relays shall be form "C," SPDT. Contacts shall be rated for 5 A resistive at 250-V ac or 30-V dc.
 - d. Contacts shall be capable of being selected normally open or normally closed.
 - e. Alarm relays shall be normally de-energized. The fault relay shall be normally energized.
 2. Analog Output:

- a. Two-wire, 4- to 20-mA, isolated or non-isolated current source.
 - b. Signal capable of operating into a 600-ohm load.
- 3. Digital Communication:
 - a. Bidirectional sending and receiving of digital signals.
 - b. Digital signals shall comply with FTT-10-based communication.
 - c. Protocol shall be LonTalk supported by Lon Works.
 - d. Signal speed shall be no greater than 78.1 kBs per second.
- K. Sensor:
 - 1. Electrochemical fuel-cell type does not require periodic addition of reagents.
 - 2. Sensor shall be replaceable without the need for tools.
 - 3. Sensors shall have a minimum useful life of one year. Replace failed sensors at no charge within first year.
 - 4. Mount sensor externally on the side or bottom of enclosure. Where indicated on Drawings, mount sensor remote from enclosure.
 - 5. Remote Mounting:
 - a. Provide sensor in a separate enclosure. Enclosure shall be NEMA 250, Type 4X, except when sensor is installed in a hazardous location, then enclosure shall be an explosion-proof type suitable for the application.
 - b. Provide sensor with cable for connecting to monitor.
 - c. Provide sensor with mounting hardware suitable for application.
 - d. For duct-mounted applications, the sensor installation shall provide kit for calibration of the sensor without removing sensor from duct.
- L. Gas Sampling Pump:
 - 1. Where required by application, provide a pump mounted inside the enclosure to provide a motive force to induce flow of gas sample across the sensor.
 - 2. Signal to the sensor from the pump shall be in digital communication format to eliminate radio-frequency interference (RFI) and electromagnetic interference (EMI).
 - 3. A flow sensor shall activate a relay when the gas sample falls below the acceptable flow rate to the sensor and shall indicate a loss of gas flow on the display.
 - 4. Introduction of a calibration gas to the gas sensor shall be through an integral push-button valve. This push-button valve shall return to monitoring the sampled area when released.
- M. Battery Backup:
 - 1. Provide battery backup power supply to continue normal operation if normal power source is interrupted.
 - 2. Transfer to battery backup shall be automatic and shall be indicated on the display.
 - 3. Mount battery backup power supply inside enclosure.
 - 4. Battery backup shall be continuously charged during normal operation.
 - 5. Battery life shall be at least 0.5 hours with strobes flashing, alarm conditions asserted, and horn sounding.
- N. Calibration:
 - 1. Calibrate and adjust functions through nonintrusive hand-held wireless remote control without opening enclosure door.
 - 2. Enter calibration mode through hand-held wireless remote control unit. The display of the monitor shall instruct the user on when to apply zero and span gas.

The system shall automatically adjust its internal settings to the proper calibration values without further intervention by the user. On completion of a successful calibration, the system shall exit the calibration mode. Date stamp of last successful calibration is retained in the system internal memory, with capability to be indicated on display. If calibration is unsuccessful for any reason, the display shall show an unsuccessful calibration attempt and revert to its previous calibration settings.

3. Wireless method shall employ a digitally encoded infrared light beam.
4. Hand-held wireless remote control shall let the user perform sensor zeroing and calibration.
5. Hand-held wireless remote control shall let the user perform sensor zeroing and calibration, as well as activate all functions and features of the monitor.
6. The monitor infrared link shall not be affected by natural and man-made low-level ambient light.

O. Automatic Calibration System:

1. Provide automatic calibration of all oxygen monitors installed. Number of automatic calibration systems shall be determined by supplier based on location and quantity of oxygen monitors.
2. Automatic calibration system shall, without manual intervention, periodically perform a complete calibration of the sensor.
3. System shall exchange digital signals with sensor.
4. Automatic calibration shall be adjustable from as many as three times per day to only once every 30 days.
5. Sensor alarms shall be suppressed or disabled until the automatic calibration cycle is completed.
6. Manual calibration of the sensor shall be initiated at any time with a hand-held infrared remote control without the need to disable or turn off the automatic calibration system.
7. House the system in a separate NEMA 250, Type 4X enclosure from the oxygen monitoring system. Enclosure shall have provisions for wall mounting.
8. Digital displays shall indicate zero and when span gas is being applied to the sensor, the status, and any fault condition.
9. Provide with a separate valve conduit to monitor the condition of the calibration cylinders attached to the calibration system. Insufficient gas pressure to calibrate the sensor shall light the fault indicator.

2.3 CARBON-MONOXIDE MONITORING SYSTEM

A. Manufacturers:

1. ACME Engineering Products, Inc
2. Ebtron, Inc.
3. Rel-Tek Corporation
4. TSI incorporated
5. Vulcain, Inc.

B. Description:

1. Each sampling point shall monitor any variation in the carbon-monoxide concentration level.
2. Each sampling point shall be individually piped to the monitoring system.
3. Provide sampling point with a 0.3-micron filter.

4. Each sampling point shall be an alarm point.
 5. Sample time shall be adjustable in 1 second increments from zero to 60 minutes.
 6. Span and zero calibration gas shall be automatically initiated by the microprocessor. System shall also provide manual initiation of span and zero calibration gas.
 7. Analyzer output shall be corrected by the microprocessor.
 8. System shall operate on 120-V ac, single-phase, 60-Hz power.
 9. Final adjustment: calibration, testing, and startup of the system shall be performed by a trained representative of manufacturer.
- C. Analyzer:
1. Analyzer shall operate using principle of nondispersive infrared absorption.
 2. Sampling response time shall be within 10 seconds.
 3. Zero drift and span drift shall be less than 1 percent of full scale within a 24-hour period.
 4. Repeatability shall be within 1 percent of full scale.
 5. Accuracy shall be within 1 percent of full scale.
 6. Calibration range shall be zero to 500 ppm.
 7. Digital display on analyzer face with scale shall be in ppm.
 8. Temperature shall be compensated from 30 to 120 deg F ambient temperature.
- D. Control and Display:
1. Each sample shall send a 4-20 mA output signal proportional to the highest concentration.
 2. Alphanumeric visual display of current analyzer concentration reading shall be in ppm or another industry-accepted measurement.
 3. Visual indication for sample analyzing, sample high-concentration alarm, analyzer malfunction, and calibration.
 4. Any number and configuration of sample points shall be capable of being bypassed.
 5. Each sample point shall be capable of being manually sampled through an override feature.
 6. System parameters shall be stored in nonvolatile memory.
 7. Provide at least an eight-hour battery backup of current alarm status. Battery shall be rechargeable.
- E. Enclosure:
1. NEMA 250, Type 1.
 2. Hinged and locking door, full size of face.
 3. House all system components. Multiple adjoining enclosures are acceptable if joined to a common support structure.
- F. Calibration Equipment:
1. Provide equipment necessary to automatically and manually calibrate the system, including, but not be limited to, the following:
 - a. Regular assembly.
 - b. Zero cap.
 - c. Calibration cap.
 - d. Two cylinders filled with calibration gas.
 - e. Instruction book.
 - f. Carrying case.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to seismic loads.
- D. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
 - 1. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 - 2. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 3. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
 - 4. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
- B. Mounting Height:
 - 1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
 - 2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
 - a. Make every effort to mount at 60 inches.
- C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.5 CARBON-MONOXIDE MONITORING SYSTEM

- A. Install sample points in monitored area to provide accurate measurement of gas concentration.
- B. Install exposed sampling points with a finished appearance consistent with other materials in space. Submit proposed products to be installed for review and approval.
- C. Individually install each sample point to the carbon-monoxide monitoring system.
- D. Install tubing in a minimum size of NPS 3/8.
- E. Use compression fittings at connections to equipment.

- F. If not indicated on Drawings, locate carbon-monoxide monitoring system in a secured and serviceable location accessible to authorized personnel.
- G. Support carbon-monoxide monitoring system from floor or wall. Support floor-mounted systems using a structural channel frame. Provide mounting brackets.

3.6 OXYGEN MONITORING SYSTEM

- A. Install monitor in space to provide an accurate measurement of gas concentration.
- B. Support oxygen monitoring system from wall.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification on face.

3.8 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 - 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 - 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 - 3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
 - 4. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
 - 5. Provide diagnostic and test equipment for calibration and adjustment.
 - 6. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
 8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
 9. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- B. Analog Signals:
1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- C. Digital Signals:
1. Check digital signals using a jumper wire.
 2. Check digital signals using an ohmmeter to test for contact.
- D. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
- E. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- F. Switches: Calibrate switches to make or break contact at set points indicated.
- G. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.10 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate gas instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.

- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 23 09 33

VARIABLE FREQUENCY DRIVES FOR HVAC APPLICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.
- B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - 2. Underwriters laboratories
 - a. UL508C
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a. ICS 7.0, AC Adjustable Speed Drives
 - 4. IEC 16800 Parts 1 and 2
- B. Qualifications:
 - 1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
 - 2. Acceptable Manufactures
 - a. ABB ACH Series.
 - b. Siemens.
 - c. Danfoss.
 - d. Square D,

1.3 SUBMITTALS

- A. Submittals shall include the following information:
 - 1. Shop Drawings: indicate outline dimensions, conduit entry locations and weight.
 - 2. Customer connection and power wiring diagrams, details and connection requirements.

3. Complete technical product description. Any portions of the specifications not complied with must be clearly indicated or the supplier and contractor shall be liable to provide all components required to meet the specification.
4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors with no exceptions.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

- A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
 1. Environmental operating conditions: 0-40°C continuous. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing.
 2. Enclosure shall be rated UL type 12 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable.
- B. All VFDs shall have the following features:
 1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
 2. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
 3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery backup with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings. Capacitor backup is not acceptable.
 4. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

5. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
 6. The VFD shall have 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.
 7. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
 8. The VFD shall provide a programmable proof of flow form c relay output (broken belt / broken coupling). The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
- C. All VFDs to have the following adjustments:
1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
 2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network.
 3. Two (2) programmable analog inputs shall accept current or voltage signals.
 4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
 5. Six (6) programmable digital inputs.
 6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
 7. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the

- damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.
8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
 9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
 10. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.
 11. The VFD shall include password protection against parameter changes.
- D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.
- E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Speed (RPM, %, or Engineering units)
 3. Motor Current
 4. Drive Temperature
 5. DC Bus Voltage
 6. Output Voltage
- F. Serial Communications
1. The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, BACnet, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Each individual drive shall have the protocol in the base VFD. All protocols shall be “certified” by the governing authority (ie BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 2. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - a. Data Sharing – Read Property – B.
 - b. Data Sharing – Write Property – B.
 - c. Device Management – Dynamic Device Binding (Who-Is; I-AM).
 - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - e. Device Management – Communication Control – B.

3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. "Pass thru I/O" All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
- G. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The VFD shall comply standard EN 61800-3 for the First Environment, restricted level with up to 100' of motor cables. No Exceptions. Certified test lab test reports shall be provided with the submittals
- H. All VFD's through 60HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not be damaged by this condition.

2.2 BYPASS AND CIRCUIT BREAKER

- A. Bypass and circuit breaker shall be UL listed, furnished and mounted by the drive manufacturer as a complete assembly and carry a UL508 label. The bypass enclosure door and VFD enclosure must be interlocked such that input power is turned off before either enclosure can be opened. The VFD and Bypass as a package shall have a UL listed short circuit rating of 100,000 amps and shall be indicated on the data label.
 1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses are required. Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted
 2. Door interlocked padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
- B. Bypass Controller:
 1. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector and light
 - c. Bypass mode selector and light
 - d. Bypass fault reset
 - e. Bypass LDC display, 2 lines, for programming and status / fault / warning indications
 2. Motor protection from single phase power conditions- The Bypass system must be able to detect a single-phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in Bypass mode are not acceptable.

3. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30% and -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.
4. The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.
5. Serial communications – the bypass and VFD shall be capable of being monitored and / or controlled via serial communications. Provide communications protocols for ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1) and BACnet.
6. BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. “Pass thru I/O” All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.
7. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD and bypass shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD system input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.
8. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.
9. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
10. The bypass control shall be programmable for manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass.

11. There shall be an adjustable motor current sensing circuit for the bypass and VFD mode to provide proof of flow indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and on a relay output contact closure.
12. The bypass controller shall have six programmable digital inputs, and five programmable form C relay outputs.
13. The relay outputs from the bypass shall be programmable for any of the following indications.
 - a. System started
 - b. System running
 - c. Bypass override enabled
 - d. Drive fault
 - e. Bypass fault
 - f. Bypass H-O-A position
 - g. Motor proof of flow (broken belt)
 - h. Overload
 - i. Bypass selected
 - j. Bypass run
 - k. System started (damper opening)
 - l. Bypass alarm
 - m. Over temperature
14. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
15. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
16. The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat”, “Freezstat”, “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
17. Class 10, 20, or 30 (selectable) electronic motor overload protection shall be included.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the requirements of the VFD manufacturer's installation manual. In case drives are wall hung units, contractor shall provide unistrut mounting brackets and reinforce the wall studs with bracing for support. Installation of the VFD shall allow for clearance in accordance with NEC for electrical panel.

3.2 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory certified service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer. Technicians from the manufacturer shall provide onsite training of 16 hours to the owner's facility and maintenance group.

3.3 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.
- B. A computer-based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.4 WARRANTY

- A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses.

END OF SECTION

SECTION 23 24 00

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the requirements for noise and vibration control systems to be used for process, mechanical, electrical, and structural work.
- B. This Specification provides the necessary design for the avoidance of excessive noise or vibration in the building due to the operation of machinery or equipment and/or due to interconnected piping, ductwork, conduit, or structures.

1.2 DEFINITIONS

- A. Structural Isolation Break (SIB): a continuous break in rigid structural, mechanical, and electrical elements over the specified region of the structure resulting in a functional separation between vibration-generating and vibration-sensitive areas.

1.3 DESIGN CRITERIA

- A. Do not install equipment piping, conduit, etc., in rigid contact with the structure unless it is required by this Specification. Structure includes slabs, beams, studs, walls, columns, lath, etc.
- B. Prior to installation, bring to JACOBS's attention conflicts that will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- C. Prior to installation, bring to JACOBS's attention discrepancies between the Specifications and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.
- D. The SIB is characterized by a complete structural separation spanned only by the following:
 - 1. Piping, ducting and conduit which are small enough to not require isolation as specified herein.
 - 2. Vibration-isolated major piping, ducting, and conduit as specified herein.
- E. Individual runs of piping, ducting, and conduit that are smaller than the sizes specified as requiring treatment at SIBs are not considered a rigid connection.

- F. Pipe Anchors and Supports: Do not allow piping supports and anchors to interfere with free operation of vibration isolation systems. Stiff leg support of piping supported on Type HS, Type FSN, or Type NP isolators is not acceptable.
- G. Ductwork: Ductwork isolation requirements specified are based on duct equivalent diameters. When evaluating isolation requirements for rectangular ductwork, the equivalent diameter is the diameter of the duct with the same cross-sectional area.
- H. Isolation/Absorption Products: The completed installation must be free of vibration and noise. Systems, equipment, or parts which vibrate or generate vibration unduly or which generate or emit undue noise while in operation require the following:
 - 1. Adjust, repair, or replace as appropriate to obtain acceptable levels of vibration or noise.
 - 2. Support on or be fitted with suppression or absorption devices or other means that effectively prevent the transmission of vibration or noise beyond the offending item.
- I. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for piping, conduit, ductwork, etc., supported on Type HS, Type FSN, or Type NP isolators. Refer to resilient penetration details on Drawings.
- J. Refer to structural and architectural drawings for specific locations of SIBs.

1.4 COORDINATION

- A. Coordinate the work under this Section with other mechanical, electrical, and structural work to accomplish the interfacing necessary to provide a complete and operating system in conformance with the intent of the Contract Documents.

1.5 SUBMITTALS

- A. Provide the following within 3 weeks of award of Contract:
 - 1. A general statement of materials and methods intended for use on this project. Provide specific information for items described under the Products section of this Specification. Provide complete specifications, descriptive drawings, catalog cuts, and descriptive literature which includes make, model, dimensions, weight, and interface description with other work. Complete performance data is required that will indicate full compliance with Specifications as outlined herein.
 - 2. Shop Drawings:
 - a. Complete detailed shop drawings showing the intended locations and construction features of products specified. Submit shop drawings in a timely manner to allow review and revision without adversely affecting construction scheduling.
 - b. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.
 - c. Drawings showing methods for suspension, support, guides, etc., for piping, ductwork, etc.

- d. Drawings showing methods for isolation of pipes, etc., piercing walls, slabs, beams, etc.
- 3. Product Data:
 - a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the Specification.
 - b. An itemized list showing items of equipment, piping, etc., to be isolated, the isolator type, and model number selected, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable.
 - c. Written approval of the frame design to be used, obtained from the equipment manufacturer.
- B. Provide the following equipment balance reports as soon as they are available:
 - 1. Factory balance reports.
 - 2. Field balance reports.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Isolator Stability:
 - 1. Select springs with sufficient diameter to maintain stability of the equipment being supported. Provide a minimum horizontal to vertical stiffness ratio no less than 1:1.
 - 2. Select springs for a minimum additional travel to solid equal to 50 percent of the rated deflection.
- B. Corrosion Protection for Indoor Installations: Treat metal parts including springs, brackets, housings, and bases with a rust-inhibiting metal primer. Alternatively, coatings as specified for outdoor installations may be used.
- C. Corrosion Protection for Outdoor Installations: Coat metal parts exposed to weather with hot-dip galvanizing (per ASTM A525), cadmium plating, or neoprene coating after fabrication.

2.2 VIBRATION ISOLATORS

- A. Type HS, Hanger Spring:
 - 1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., Model RSH
 - b. Kinetics Noise Control Inc., Model SH.
 - c. Mason Industries Inc., Model 30N.
 - 2. Construction: stable steel spring, removable for field correction, and a neoprene-in-shear or fiberglass isolator placed in series and encased in a welded steel bracket.
 - 3. Spring Element Overload Capacity: minimum 40 percent.
 - 4. Diameter/Height Ratio: The overall diameter of the spring shall be not less than 0.8 times the operating height of the spring.

5. Minimum Operating Static Deflection - As Specified Except as Follows:
 - a. For 3- and 4-Inch Deflections if the Hanger Load is Between 250 Pounds and 25 Pounds per Hanger:
 - 1) Provide specified deflection hangers rated for 250-pound applied load.
 - 2) Alternatively, provide reduced deflection hangers with spring constants not greater than 65 pounds per inch.
 - b. For 2-Inch Deflection if the Hanger Load is Between 100 Pounds per Hanger and 25 Pounds per Hanger:
 - 1) Provide specified deflection hangers rated for 100-pound applied load.
 - 2) Alternatively, provide reduced deflection hangers with spring constants not greater than 50 pounds per inch.
 6. Identification: Color code springs.
 7. Hanger Brackets: Design to carry a minimum five times overload without failure and to allow not less than 15 degree rod misalignment without short circuiting.
- B. Type FSN, Floor Spring and Neoprene:
1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., Model A.
 - b. Kinetics Noise Control Inc., Model FDS.
 - c. Mason Industries Inc., Model SLF.
 2. Description: adjustable, freestanding, stable, open-spring mountings of specified minimum static deflection with combination leveling bolts and equipment fastening bolts. Rigidly attach springs to spring-mounting baseplates and compression plates. Provide spring elements with 50 percent overload capacity. Overall diameter of springs shall be not less than 0.8 times the operating height of the springs. Bond neoprene pad having a minimum thickness of 1/4 inch to the baseplate.
 3. The use of nested springs or of multiple parallel springs within a single mount is not permitted.
- C. Type FSNTL, Floor Spring and Neoprene Travel Limited:
1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., Model AWR-1.
 - b. Kinetics, Model FLS.
 - c. Mason Industries Inc., Model SLR.
 2. Description: adjustable, freestanding, and laterally stable without housing, of specified minimum static deflection with combination leveling bolts and equipment fastening bolts. Rigidly attach springs to spring-mounting baseplates and compression plates. Provide spring elements with 50 percent overload capacity. Overall diameter of springs shall be not less than 0.8 times the operating height of the springs. Provide mounts with vertical travel limit stops to control extension when weight is removed. Provide travel limit stops capable of serving as blocking during erection of the equipment. Bond neoprene pad having a minimum thickness of 1/4 inch to the baseplate.

- D. Type FN, Floor Neoprene:
1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., Model R/RD.
 - b. Kinetics Noise Control Inc., Model RD.
 - c. Mason Industries, Model ND.
 2. Description: Neoprene-in-shear type with steel reinforced top and base. Cover metal surfaces with neoprene. Rib top and bottom surfaces. Provide bolt holes in the base and the top and include a threaded fastener. Include leveling bolts that may be rigidly connected to the equipment with mount.
- E. Type NP, Neoprene Pad:
1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., Model Shear-Flex or Maxi-Flex.
 - b. Kinetics Noise Control Inc., Model NPS.
 - c. Mason Industries, Model W.
 2. Description: one layer of 1/4-inch to 5/16-inch thick ribbed or waffled neoprene. Neoprene shall be 40 to 50 durometer. Size so that they will be loaded within the manufacturer's recommended range.
 3. Unless otherwise specified, isolators shall not be short circuited by through-bolting. Provide required restraint with snubbers.
- F. Type DNP, Double Neoprene Pad:
1. Acceptable Manufacturers:
 - a. Vibration Mountings & Controls, Inc., model multiple layers of Shear-Flex or Maxi-Flex.
 - b. Kinetics Noise Control Inc., Model NPS.
 - c. Mason Industries, Model WSW.
 2. Description: double neoprene vibration isolator with cast-in metal inserts for bolting to equipment. Provide upper rib molded and lower surfaces for skid resistance. Furnish cast-in steel baseplates and mounting holes for floor attachment as required.
 3. Minimum Static Deflection: 0.3 inch unless otherwise specified.

2.3 EQUIPMENT BASES

- A. General:
1. Coordination: Furnish equipment bases and isolators by the same manufacturer to ensure a coordinated system.
 2. Painting of Bases: Prime coat with rust-inhibiting paint.
- B. Inertia Bases:
1. Base Construction:
 - a. General Description: stone-aggregate concrete (150-pcf) slabs cast into prefabricated inertia base frame assemblies.
 - b. Base Frames: welded structural steel beams or channels with 1/2-inch steel reinforcing rods or angles located 1-1/2 inches above the bottom on maximum 6-inch centers each way. Provide additional steel as required by structural conditions.
 - c. Concrete: as specified in Section 03 30 00 – Cast-In-Place Concrete.

- d. Base Depth: minimum of 8 percent of the long dimension of the base but not less than 6 inches.
 - e. Anchor Bolts: House anchor bolts in a steel bolt sleeve that allows minor location adjustment. Prelocate whenever possible and fix into position.
 - f. Configuration:
 - 1) Provide rectangular bases except for pump bases, which may be T shaped.
 - 2) Provide split-case pump bases wide enough to support suction and discharge elbows.
 - 3) Provide centrifugal pump bases long enough to support inlet elbows or suction diffusers if present.
 - 2. Type BIB, Base Inertia Base:
 - a. Acceptable Manufacturers:
 - 1) Vibration Mountings and Controls, Inc., Model WPF.
 - 2) Kinetics Noise Control Inc., Model CIB-L or CIB-H
 - 3) Mason Industries Inc., Model KSL
 - b. Description: Inertia base as specified above with height-saving mounting brackets welded to the outside of perimeter frame and designed for use with isolators.
 - c. Clearance: Maintain 1-inch clear below bases.
- C. Structural Bases and Rails:
- 1. General:
 - a. Description: welded structural steel beams or channels with outboard isolator brackets and prelocated equipment anchor bolts. Provide additional steel as required by structural conditions.
 - b. Rigidity: Provide bases rigid enough to support the equipment without flexing and to resist starting, operating, and seismic forces without supplemental hold-down devices. Provide cross members where necessary to support the equipment and to prevent twisting of the main members.
 - c. Base Depth: minimum of 10 percent of the long dimension of the base but not less than 6 inches. Maximum depth shall be 12 inches except where structural or alignment considerations dictate otherwise.
 - d. Configuration:
 - 1) Provide bases rectangular except for centrifugal refrigeration machines and pump bases that may be L or T shaped.
 - 2) Provide split-case pump bases wide enough to support suction and discharge elbows.
 - 3) Provide centrifugal pump bases long enough to support inlet elbows and suction diffusers if present.
 - e. Mounting Brackets: Provide height-saving mounting brackets welded to the outside of the perimeter channel frame, designed for use with isolators.
 - f. Clearance: Maintain 1-inch clear below bases.
 - g. Junior Beams and Junior Channels: prohibited.

2. Type BSR, Base Steel Rail:
 - a. Acceptable Manufacturers:
 - 1) Kinetics Noise Control Inc., Model KRB or KFB.
 - 2) Vibration Mountings and Controls, Inc., Model WFR
 - 3) Mason Industries Inc., Model CMAB or Model R or ICS.
 - b. Description: prefabricated extruded aluminum support rail with stable steel springs of specified deflection and a continuous air and water seal. Design rails for the support of curb-mounted air-handling units. Include rail base side mounting brackets for attachment of vibration isolators. Design rails shall provide seismic and wind load restraint as required and not interfere with operation of the spring isolators.
 - c. Fan Rectangular Bases: Provide NEMA standard motor slide rails.
3. Type BSF, Base Steel Frame:
 - a. Acceptable Manufacturers:
 - 1) Vibration Mountings and Controls, Inc., Model WFB.
 - 2) Kinetics Noise Control Inc., Model SFB or SRB.
 - 3) Mason Industries, Inc., Model WFSL.
 - b. Description: structural steel sections sized, spaced, and connected to form a rigid base which will not twist, deform, or deflect in any manner which will negatively affect the operation of the supported equipment of the vibration isolation mounts. Size frames to support basic equipment units and mounts plus associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame bases shall be at least 1/10 the longest dimension of the base with a minimum depth of 6 inches, but not more than 12 inches. Include with frame side mounting brackets for attachment of vibration isolators. Locate mounting brackets on the sides of the base that are parallel to the axis of rotation of the supported equipment.

2.4 FLEXIBLE CONNECTORS

- A. Flexible Duct Connections: Provide flexible duct connections in accordance with industry standards. Provide material width 150 percent of clear dimension in addition to width required for attachment. Flexible duct connections shall result in a loose and highly compliant connection between ducts, fans, etc.
- B. Flexible Pipe Connectors:
 1. Acceptable Manufacturers:
 - a. Mason Industries, Model SFDEJ, MFTFU, or MFNEC.
 - b. Metraflex, Model Metraflex Twin Sphere of El Sphere.
 - c. Vibration Mountings and Controls, Model 2600, 2655, or 2700-EL.
 2. Flexible pipe connectors shall be fabricated of nylon cord, fabric, and neoprene. Flexible connectors resulting in a flexible and highly compliant connection that can allow longitudinal, transverse, and angular movements and provide microvibration isolation. Rods or cables may be used to control extension of the

connector, if required by the manufacturer, but shall not inhibit movement necessary to provide sufficient vibration isolation.

- C. Flexible Conduit Connections:
 - 1. Flexible Conduit: Form from one continuous length of electrogalvanized spirally wound steel strip.
 - 2. Liquidtight Flexible Conduit: Form from one continuous length of electrogalvanized spirally wound steel strip with neoprene jacket.

PART 3 - EXECUTION

3.1 GENERAL

- A. Select vibration isolation in accordance with the 2011 ASHRAE Applications Handbook, Table 47 "Selection Guide for Vibration Isolation".
- B. Request inspection by JACOBS prior to closing installations to be covered or enclosed.
- C. Obtain instructions from the vibration isolation manufacturer as to proper installation and adjustment of vibration isolation devices.
- D. Correct (at no additional cost) installations which are deemed JACOBS to be defective in workmanship or materials.
- E. The Contractor is responsible for proper operation of systems, minor subsystems, and services provided under this Section. Coordinate startup procedures, calibration, and system checkout with contractors involved. Diagnose system operational problems and initiate correctional procedures by the various contractors to bring the systems into compliance with the design. Recheck the problem to verify that the system operates normally. Bring remaining difficulties to the attention of JACOBS.

3.2 ISOLATOR INSTALLATION

- A. The installation or use of vibration isolators shall not cause change of position of equipment, conduit, piping, or ducting which would result in stresses in connections or misalignment of shafts or bearings. To meet this objective, maintain equipment and attached systems in a rigid position during installation. Avoid transferring load to the isolator until the installation is complete and under full operational load. Fully support plumbing, piping, and ducting at mechanical equipment connections using specified hangers. Mechanical equipment and vibration mounts shall not carry plumbing, piping, or ducting loads.
- B. Equipment Isolator Installation:
 - 1. Support the machine to be isolated with a structural steel frame or with brackets attached directly to the machine where no frame is required.
 - 2. Use space saver brackets for equipment supported on Type FSN vibration isolators.

3. Provide 1-inch minimum operating clearance between the underside of the frame or inertia base and the pad or floor.
 4. Place the frame in position and support temporarily on shims prior to the installation of the machine or isolators.
 5. After the system installation is completed and under operational load, adjust isolators so that the load is transferred from the shims to the isolators. When isolators are properly adjusted, the shims will be barely free. Remove the shims.
- C. Isolator Hangers:
1. Install isolators with the isolator hanger box as close as possible to the structure.
 2. Suspend isolators from massive beams, not from slab diaphragms between beams.
 3. Orient isolator assemblies including support and load rods to within 5 degrees of vertical.

3.3 EQUIPMENT ISOLATION

- A. Install isolators for fans, compressors, and other such equipment as shown on vibration isolation schedule or as otherwise required. Unless otherwise specified in vibration isolation schedule or elsewhere or reviewed in advance by JACOBS, no equipment of more than 1 horsepower is to be attached to the structure without suitable vibration isolation. Where piping connects to such equipment, provide flexible pipe connectors as specified herein on the Drawings.
- B. Obtain mechanical equipment manufacturer approval for complete vibration isolation system for isolated equipment.

3.4 PIPING ISOLATION

- A. General:
1. Beyond 50 feet from isolated mechanical equipment, support piping greater than 4 inches in diameter and racks supporting piping with equivalent or greater cross-sectional areas that are supported from structures above on minimum 1-inch deflection Type HS hangers.
 2. Vacuum, compressed air, gas, gravity drain, fire protection piping, are exempt from vibration isolation requirements and from calculations for equivalent areas. Piping less than 1 inch in diameter is exempt from calculations for equivalent areas.
- B. At Vibration-Isolated Mechanical Equipment:
1. Isolation requirements specified below are based on metal pipe interior diameters. When evaluating isolation requirements for plastic pipe, determine effective pipe diameter by dividing the interior diameter by two.
 2. For vibration-isolated equipment located in the service yard, provide vibration isolation flexible pipe connections.
- C. Passive Mechanical Equipment:
1. Passive mechanical equipment refers to equipment without motors such as cooling coils, plate and frame heat exchangers, etc.

2. At passive mechanical equipment connected to vibration-isolated mechanical equipment by less than 50 horizontal feet of pipe with a diameter equal to or greater than 1-1/2 inches:
 - a. Provide vibration isolation flexible pipe connection at passive equipment and at vibration-isolated mechanical equipment.
 - b. Support pipe between mechanical and passive equipment on same type and deflection hanger as mechanical equipment support.
- D. Where vibration-isolated piping is connected to rigidly supported piping with a diameter greater than 1 inch, provide vibration isolation flexible pipe connection or support un-isolated pipe on same type and deflection isolator for the first support point.
- E. If a conflict in isolation requirements exists, the most stringent requirement applies.

3.5 SHEET METAL DUCT ISOLATION

- A. General:
 1. Sheet Metal Ducting with an Equivalent Diameter of 24 Inches or Greater Supported from Structures Above: Support on 1-inch deflection Type HS hangers.
 2. Where rigidly supported sheet metal ductwork with an equivalent diameter equal to or greater than 18 inches attaches to vibration-isolated sheet metal ductwork, provide flexible duct connection or 1-inch deflection Type HS hanger for the first support point.
- B. At Vibration-Isolated Equipment: Support sheet metal ductwork attached to vibration-isolated equipment on vibration isolators of same type and deflection as isolated equipment for the first 50 horizontal feet. Air handlers with internally isolated fans are exempt from this requirement.
- C. Passive Equipment:
 1. Passive mechanical equipment refers to equipment without motors, i.e., cooling coils, filter boxes, etc. For vibration isolation purposes, rigidly supported exhaust stacks are considered as passive equipment.
 2. At passive mechanical equipment connected to vibration-isolated equipment by less than 50 horizontal feet of ductwork, provide flexible duct connectors at passive equipment or support passive equipment on same type and deflection isolators.
 3. Passive equipment located within air handlers is exempt from this requirement.
- D. If a conflict in isolation requirements exists, the most stringent requirement applies.

3.6 ELECTRICAL connections

- A. Vibration-Isolated Mechanical Equipment: Make electrical service connections using flexible conduit. Provide conduit with a minimum 90 degree turn and result in loose and compliant connections.

3.7 FACTORY BALANCE SPECIFICATION

- A. General:
 - 1. Due to the vibration sensitivity of process and assembly equipment, specific dynamic requirements have been placed on structures and mechanical systems. Significant horsepower of mechanical equipment with attendant vibration dictates strict balance requirements.
 - 2. Advise manufacturers that selection and submittal with subsequent delivery and installation of mechanical equipment not meeting the Specifications will result in the following:
 - a. Nonpayment for product.
 - b. Bearing cost to remove defective product and replacement with acceptable product not necessarily of the same manufacturer.
- B. Factory Balance:
 - 1. Factory balance rotating equipment in accordance with the following procedure: During factory dynamic balance, load equipment with design loads. Balancing must be performed on an elastic suspension test apparatus. This test base must weigh no more than 15 percent of the equipment weight and provide a minimum of 1-inch actual spring deflection.
 - 2. Make vibration measurements in three orthogonal axes at each bearing location. Measure overall velocity in the frequency range of 8 Hz to 200 Hz and report to CH2M HILL.
 - 3. Maximum allowable vibration on centrifugal and rotary fans, pumps, compressors, chillers, etc., is 0.1-inch-per-second peak in any axis.

3.8 BALANCE VERIFICATION TESTING

- A. General:
 - 1. The Owner may have balance verification testing performed by others on selected rotating equipment. Perform testing by an independent vibration testing firm regularly engaged in vibration testing and balance work.
 - 2. Perform balance measurements in accordance with methodology specified in paragraphs 3.9.B and 3.10.B below.
 - 3. Noncompliance with Vibration Specifications:
 - a. Inform the equipment manufacturer of noncompliance with specified vibration limits. Field balance the equipment within 1 week of the date of notification of the equipment manufacturer.
 - b. The equipment balance will then be retested at the manufacturer's expense by an independent testing firm approved by the Owner. Submit equipment balance, as measured by the testing firm, to JACOBS.
 - c. If the manufacturer does not field balance the deficient equipment within the specified time period, the Owner may take corrective steps at the manufacturer's expense.
 - d. If the equipment is not in compliance with specified field vibration limits after manufacturer's field balancing, the Owner may take corrective steps at the manufacturer's expense.

B. Balance Procedure for Equipment Supported on Inertia Bases:

1. Inertia bases radically alter bearing displacement response of pumps, fans, etc. During verification testing of factory balances, take into account dynamic inertial effects.
2. The inertial mass results in reduced bearing displacements in accordance with the following formula:

$$\frac{1}{(MT / M + 1)}$$

Where:

MT = Inertia mass (base, excluding equipment and motor mass)

M = Equipment + motor mass

3. Allowable bearing vibration for mechanical equipment is, therefore, reduced by this amount.
4. For example, the field balance for centrifugal fans mounted on 1:1 inertia bases is velocity at or below 0.5-inch-per-second peak (0.5 by 0.1 inch per second).

END OF SECTION

SECTION 23 29 00

DUCTWORK INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the requirements necessary to furnish and install ductwork thermal insulation and internal sound attenuation insulation.

1.2 QUALITY ASSURANCE

- A. Provide insulation with composite (insulation-jacket-adhesive) fire and smoke hazard ratings not exceeding a flame spread of 25 and smoke developed of 50, as tested by Procedure ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials, NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials, and UL 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.
- B. Provide interior duct lining materials meeting the life safety standards as established by NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
- C. Installer qualifications: firm with a minimum of 3 years' experience in ductwork insulation application.
- D. Manufacturer Qualifications: firm with a minimum of 10 years' experience in ductwork insulation manufacturing.

1.3 Submittals

- A. Provide the following within 3 weeks of award of Contract:
 - 1. Product data sheets for all insulation, liners, and adhesives.
 - 2. Manufacturer's instructions for installation.

PART 2 - PRODUCTS

2.1 EXTERNAL DUCT INSULATION

- A. Materials:
 - 1. Type A:
 - a. Flexible glass-fiber insulation, thickness as scheduled, 3/4-pcf density, with UL-labeled foil vapor barrier.
 - b. Thermal conductivity no greater than 0.31 Btu-inch per hour- ft² degrees F at 75 degrees F.

- c. Acceptable Manufacturers:
 - 1) CertainTeed Corp: Duct Wrap Insulation, Type 75.
 - 2) Johns Manville: R-Series Microlite.
 - 3) Knauf Fiber Glass: Knauf Duct Wrap.
 - 4) Owens Corning: Fiberglas All Service Duct Wrap.

2.2 ACCESSORIES

- A. Adhesives: water based; Miracle PF 102.
- B. Lagging Adhesive: fire resistive.
- C. Welded Fasteners: galvanized steel pin and washer fastener.
- D. Tie Wires: galvanized, 20 gauge.
- E. Joint Tape: foil scrim kraft (FSK) tape.
- F. Impale Anchors: galvanized steel, 13-gauge nail, self-adhesive pad, 30-gauge galvanized steel washers.

PART 3 - EXECUTION

3.1 FIELD PREPARATION

- A. Install external insulation materials after ductwork has been cleaned, sealed, and has passed pressurization tests.
- B. Clean surfaces to encourage adherence of adhesives.

3.2 INSTALLATION

- A. General: Install materials in accordance with the manufacturer's instructions.

3.3 ATTACHMENTS

- A. The following attachment is a part of this Specification:
 - 1. Ductwork Insulation Schedule

DUCTWORK INSULATION SCHEDULE

Location	Insulation Type	Insulation Thickness (Inches)	Notes
Primary air distribution ductwork	A	2	
Supply air ductwork	A	2	

DUCTWORK INSULATION SCHEDULE

Location	Insulation Type	Insulation Thickness (Inches)	Notes
Return air ductwork	A	2	
Return air ductwork in unconditioned spaces	A	2	
Exhaust air ductwork	NONE	N/A	
Outside air ductwork	A	2	
Toilet room exhaust ductwork	NONE	N/A	
Plenums (indoor)	A	2	
Supply air in mechanical rooms	A	2	
Ductwork at fans	A	2	
Supply air ductwork exposed in spaces	A	2	
Terminal unit air distribution ductwork	A	2	

END OF SECTION

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SECTION 23 31 01

METAL HVAC DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the work necessary to furnish and install, complete, metal HVAC ductwork systems with pressure classifications ranging from negative 3 inches WC to positive 10 inches WC.
- B. The SMACNA publication HVAC Duct Construction Standard - Metal and Flexible generally governs the material gauges and the fabrication and installation techniques for systems specified in this Section. SMACNA criteria are superseded by the requirements of this Section. Use current adopted edition.
- C. In the event of conflict regarding metal HVAC ductwork and accessory requirements between this Section and another section, the provisions of this Section govern.

1.2 REFERENCES

- A. Where required to provide design, based upon criteria imposed by this Section, use current adopted editions of the following SMACNA publications as a minimum:
 - 1. HVAC Duct Construction Standards – Metal and Flexible.
 - 2. Fire Damper and Heat Stop Guide for Air-Handling Systems.
- B. NFPA Publications (use current adopted edition):
 - 1. 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. 91 – Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying.

1.3 DEFINITIONS

- A. Duct: A tube or channel, including fittings, through which a gas moves.
- B. Ductwork: A system of interconnected ducts and duct accessories, including, but not limited to, isolation and balancing dampers, smoke and/or fire dampers, access doors, turning vanes, flexible connections, air extractors, hangers and supports, and other miscellaneous items required for a completely operable and adjustable system.
- C. Nonclean Areas:
 - 1. Primary Air Distribution Ductwork: Ductwork and duct accessories from the discharge of the air-handling unit to the respective terminal unit primary air inlet.
 - 2. Terminal Unit Distribution Ductwork: Ductwork and duct accessories from the discharge of the terminal unit to the respective terminations, outlets, and free discharge openings.

3. Terminal Unit Return Ductwork: Ductwork and duct accessories on the inlet of a fan-powered terminal unit (not ductwork connected to the primary air inlet).
4. Supply Air Ductwork: Ductwork and duct accessories from the discharge of fans and air-handling units to their respective terminations, outlets, and free discharge openings.
5. Return Air Ductwork: Ductwork and duct accessories from duct terminations, grilles, and air inlets to the inlets of the respective fans, return fans, and air-handling units.
6. Exhaust Air Ductwork: Ductwork and duct accessories from duct terminations, grilles, and air inlets to the inlet of respective exhaust fans and from the discharge of the respective exhaust fans to the discharge termination to outdoors.
7. Transfer Air Ductwork: Ductwork and duct accessories used to transfer air from a room of higher pressure to a room of lower pressure beginning at the grille or inlet of the air source and terminating at the grille, diffuser, or discharge outlet. Ductwork connected to a transfer fan is considered to be supply and return air ductwork as described above.

1.4 DESIGN REQUIREMENTS

- A. Supports, Anchorage, and Restraints:
 1. General:
 - a. When supports and anchorages for equipment and supports for ductwork are not shown on the Drawings, provide for their design.
 - b. Provide duct supports independent of other utilities.
 - c. Provide supplementary steel as required to prevent connections to structural framing from twisting, torsion, or lateral bending in the framing members.
 2. Engineered Support Systems: Provide support system design, details, and seal of a professional engineer registered in the state in which the project is located for the following supports:
 - a. Support frames for ductwork and equipment that provide support from the roof below.
 - b. Equipment and support frame anchorage to supporting slab or structure.

1.5 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of the submittal requirements for this section.

1.6 QUALIFICATIONS

- A. Fabricate and install sheet metal work using qualified, experienced mechanics as specified herein.

1.7 COORDINATION

- A. The Drawings do not attempt to show exact details of ductwork. No extra payment will be allowed for obstruction by work of other trades or local obstructions to the work

which require offsets. Where diagrams have been made to show duct connections, the diagrams not be used for obtaining material quantities.

- B. Submit changes in location of equipment or ductwork, advisable in the opinion of the Contractor, for review before proceeding with the work. Verify measurements and dimensions at the site.
- C. Duct sizes shown on the Drawings represent the nominal free area required for that service. Where changes in duct dimensions are necessary to coordinate the installation, the Contractor may change to an equivalent duct area with different dimensions as determined using a Trane Ductulator or Carrier or ASHRAE equivalence charts.
- D. Coordination with Existing Conditions and Other Trades:
 - 1. Coordinate the installation of ductwork with existing conditions and the work of other trades to allow the installation of ductwork and the proper operation of dampers, operators, and duct access doors.
 - 2. Relocate existing thread rod, strut material, miscellaneous supports, conduit, or piping under 1-inch diameter where it obstructs the passage of the ductwork at no additional cost to the Owner. Coordinate the work with other trades.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ductwork Materials:
 - 1. Galvanized Steel (GS): Hot-dipped GS sheet, lock-forming grade, conforming to ASTM A924 and A653, having G90 zinc coating in conformance with ASTM A90, unless heavier galvanizing is specified.
 - 2. Hot-Rolled Steel (HRS): HRS sheet, commercial quality, conforming to ASTM A568 and A569, or A366 (cold-rolled) plate with hot-rolled structural steel shapes, in conformance with ASTM A6 and ASTM A36.
 - 3. Aluminum (AL):
 - a. AL Sheet: Alloy 3003-H14 conforming to ASTM Standard B209.
 - b. AL Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
 - 4. Stainless Steel (SS): Type 304 or 316 SS sheet, as scheduled, with No. 2B finish conforming to ASTM A167 and A480; matching type structural members conforming to ASTM A666; Type 316 SS fasteners.
- B. Sealants and Tapes:
 - 1. Duct Sealer – Acceptable Manufacturers:
 - a. United Duct Sealer.
 - b. Duro-Dyne HPS Sealant.
 - c. Vulkem (one-part polyurethane) Sealant.
 - d. 3M Fastbond Duct Sealer 900.
 - 2. Tape and Adhesive/Activator System:
 - a. Acceptable Manufacturer: Hardcast.

- b. Description:
 - 1) Hardcast Type DT tape and FTA-20 (indoors) or RTA-50 (outdoors) adhesive.
 - 2) Do not use Hardcast within cleanrooms or in locations where it is exposed to air to be recirculated back to cleanrooms. Use NASHUA No. 324A tape under this circumstance.
 - 3. Duct Tape - Acceptable Manufacturers: NASHUA No. 357 silver cloth tape.
 - 4. Shrink Band (Round Ducts Only) – Acceptable Manufacturer: Raychem Flexcad.
 - 5. Silicone Sealant (SS Ductwork Only) – Acceptable Manufacturers:
 - a. Clear GE Construction 1200.
 - b. Dow 999A.

2.2 RECTANGULAR HVAC DUCTWORK

- A. Materials: Construct rectangular HVAC ductwork and components and accessories from materials specified above as scheduled in Section 23 31 13.01 – Ductwork Schedule, except as noted on Drawings.
- B. Fabrication:
 - 1. General: Fabricate ductwork from sheet material equaling or exceeding minimum wall thickness and reinforcing as scheduled in the SMACNA rectangular duct construction schedules to comply with duct pressure classifications specified. Cross break or bead duct widths over 12 inches and horizontal surfaces to prevent ballooning or breathing.
 - 2. Fittings:
 - a. General: Fabricate fittings for lowest air pressure drop.
 - b. Radius Elbows: Fabricate with centerline radius equal to or greater than one and one-half times the duct dimension in the plane of the turn.
 - c. Mitered Elbows: Provide with turning vanes as specified under ductwork accessories.
 - d. Branch Takeoffs, Rectangular to Rectangular:
 - 1) 3 Inches WC and Greater Pressure Class: Use parallel flow branches where possible. Where branch taps be made, use 45-degree entry with $L = 1/4$, 4 inches minimum.
 - 2) 2 Inches WC and Lower Pressure Class:
 - a) Use parallel flow branches where possible. Where branch taps be made, use 45-degree entry with $L = 1/4$, 4 inches minimum.
 - b) Extractors fixed at 12 degrees may be used for short runs and where shown on Drawings.
 - e. Joints:
 - 1) Longitudinal: Pittsburgh lock flooded with mastic prior to assembly. Snaplock is unacceptable.
 - 2) Transverse: Use demountable joint system, such as Ductmate, Nexus, or TDC on rectangular ductwork except where it is impractical. Seal corners prior to assembly.

2.3 HVAC FLEXIBLE DUCTWORK

- A. Standards and Listings: Comply with NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems and UL 181 Standard for Safety Factory-Made Air Ducts and Connectors for Class 1 air duct.
- B. Materials:
 - 1. HVAC Application (3 Inches WC and Lower Pressure Class):
 - a. Acceptable Manufacturer: Thermaflex M-KF.
 - b. Wire Helix: Zinc coated, or vinyl coated, high-carbon steel.
 - c. Interior Liner: Acoustically treated CPE air barrier bonded to wire helix.
 - d. Insulation: Minimum 1-inch-thick blanket of fiberglass, factory installed and bonded to the duct liner.
 - e. Jacket: Factory-applied, scuff-resistant, fiberglass-reinforced metalized film laminate vapor barrier with three-ply standing support slam.
 - f. Maximum Length: 7 feet.
 - g. Operating Ratings: 10 inches WC positive pressure for diameters 12 inches and under, 1-inch WC negative pressure; 4,000 fpm maximum velocity.

2.4 DUCT ACCESSORIES

- A. General: Fabricate duct accessories from the same material as the ductwork in which the accessory will be installed, unless specified otherwise.
- B. Manual Splitter Dampers: Fabricated from 18-gauge metal of the same material as the ductwork with splitters long enough to completely close the branch duct without flutter. Provide a locking quadrant and align its operating handle with the damper blade.
- C. Manual Single-Blade Balancing Dampers (2 Inches WC Construction):
 - 1. Fabricate in accordance with SMACNA standards, except as detailed on the Drawings and as specified.
 - 2. Provide dampers of length suitable to shut off branch ducts without causing damper flutter.
 - 3. Cross-break dampers and stiffen edges with two edge brakes for rigidity. Provide additional stiffening angles, as required.
 - 4. Provide continuous rods and outside end bearings or provide inside end bearings for dampers installed in internally lined ducts. Mark the ends of damper rods with a saw-cut to indicate blade position.
 - 5. Maximum single-blade balancing damper size is 12 by 12 inches. Provide manual opposed-blade balancing dampers in ducts wider than 12 inches. Section damper blades over 48 inches wide horizontally.
 - 6. Provide specified locking quadrants for ductwork serving nonclean areas. Provide specified dial regulators for ductwork serving cleanrooms.
- D. Manual Opposed-Blade Balancing Dampers (2 Inches WC Construction):
 - 1. Fabricate in accordance with SMACNA standards, except as detailed on the Drawings and as specified.

2. Provide blades center crimped for stiffness and to receive pins and rods and edge crimped to interlock with adjacent blades on full shutoff. Provide additional stiffening angles, as required.
 3. Provide a prime-coated or galvanized channel frame for mounting of bearings with angle stops on top and bottom.
 4. Mark the ends of the damper shaft extension with a saw-cut to indicate blade position.
 5. Provide SMACNA-accepted linkage and hardware as manufactured by Ventfabrics, Inc., arranged for gang operation and opposed-blade action without jamming or racking.
 6. Provide oil-impregnated bronze bushings for GS dampers, sized to match with pins. Provide nylon bushings for aluminum and stainless-steel ductwork.
 7. Provide blades with a minimum of 18-gauge steel or equal strength aluminum maximum blade width of 12 inches. Provide multi-section dampers for dampers over 48 inches wide.
 8. Provide specified locking quadrants for ductwork.
- E. Manual Opposed-Blade Balancing Dampers (3 to 6 Inches WC Construction):
1. Acceptable Manufacturer: Ruskin.
 2. Provide blades center crimped for stiffness and to receive pins and rods and edge crimped to interlock with adjacent blades on full shutoff. Provide additional stiffening angles, as required.
 3. Provide a prime-coated or galvanized channel frame for mounting of bearings with angle stops on top and bottom.
 4. Mark the ends of the damper shaft extension with a saw-cut to indicate blade position.
 5. Provide SMACNA-accepted linkage and hardware as manufactured by Ventfabrics, Inc., arranged for gang operation and opposed-blade action without jamming or racking.
 6. Provide stainless steel bearings.
 7. Provide blades with a minimum of 16-gauge steel or equal strength aluminum and maximum blade width of 8 inches. Provide multi-section dampers for dampers over 48 inches wide.
 8. Provide specified locking quadrants for ductwork.
- F. Motorized Dampers:
1. Provide continuous rods on motorized damper assemblies.
 2. Locate actuator outside the airstream.
 3. Provide actuator sized by and provided by the damper manufacturer.
 4. Install the actuator as specified and in accordance with the manufacturer's written directions.
 5. Provide electric actuators with 24V ac/V dc power supply.
- G. Regulators and Quadrants:
1. Acceptable Manufacturers:
 - a. Ventfabrics, Inc. (Ventlok).
 - b. Duro-Dyne Specline/Quadline.

2. Concealed Accessible Uninsulated Ductwork:
 - a. Ventlok Figure 635 dial regulator and 607 end bearing.
 - b. Ventlok Figure 555 locking quadrant and 607 end bearing.
 3. Concealed Accessible Insulated Ductwork:
 - a. Ventline Figures 637 or 639 dial regulator and 607 end bearing to match insulation thickness.
 - b. Ventline Figure 555 locking quadrant with an elevated standoff and 607 end bearing of the same height as the insulation thickness.
 4. Concealed Inaccessible Ductwork: Ventlok Figure 677 concealed damper regulator with plain cover, extended rod, and universal joints and miter gears as required.
 5. Exposed Uninsulated Ductwork in Finished Spaces or Cleanrooms: Hi-Vel Ventlok Figure 640 dial regulator with 609 end bearing.
 6. Insulated Ductwork Serving Cleanrooms:
 - a. Ventlok Figure 641 dial regulator with Hi-Vel hardware and Figure 609 end bearings. Trim and tape insulation as required for full stroke of damper handle.
 - b. Locking quadrants as specified for noncleanroom areas may be furnished, providing that the damper hardware is airtight at duct penetrations without the use of additional sealants.
- H. Turning Vanes:
1. Acceptable Manufacturers:
 - a. Elgen All-Tight.
 - b. Duro-Dyne Vane Rail.
 2. Description: Hat channel or embossed vane side rails with shop-fabricated, double-blade turning vanes of the same material as the ductwork.
- I. Air Extractors:
1. Acceptable Manufacturers:
 - a. Carnes Model RXVA, Style 3.
 - b. Titus Type AG-45, with operator No. 3.
 2. Description: Synchronized steel curved extractor blades, mounted on heavy side rails with a screw operator. Furnish on takeoffs from main ducts adjacent to diffusers or grilles where a splitter is not used.
- J. Flexible Connectors:
1. Acceptable Manufacturers:
 - a. Ventfabrics.
 - b. Duro-Dyne.
 2. Indoor Applications:
 - a. Description: Neoprene-coated, fire-retardant woven glass fabric, minimum 30-ounce-per-square-yard density, UL listed, crimped into metal edging strip with 2-inch minimum clearance between equipment and ductwork, unless otherwise indicated.
 - b. Products:
 - 1) Ventfabrics: Ventglass.
 - 2) Duro-Dyne: Neoprene metal fab or super metal fab.

3. Outdoor Applications:
 - a. Description: Hypalon-coated, fire-retardant woven glass fabric, minimum 24-ounce-per-square-yard density, UL listed, crimped into metal edging strip, with 2-inch minimum clearance between equipment and ductwork, unless otherwise indicated.
 - b. Products:
 - 1) Ventfabrics: Ventlon.
 - 2) Duro-Dyne: Durolon metal fab or super metal fab.

K. Duct Access Doors:

1. Acceptable Manufacturers:
 - a. Ventfabrics.
 - b. Duro-Dyne.
 - c. Ruskin.
2. Description:
 - a. Double-wall access door with minimum 1-inch-thick insulation between walls, angle, or Z-frame, sealing gasket around the periphery, double layer Plexiglas vision panel with air space between, hinged with Ventlok No. 100 quick-release latches. Access doors smaller than 12 inches square may be secured with sash locks.
 - b. Provide sizes as follows:

Duct Size	Frame Size	Number of Hinges	Access Requirements
6 thru 8 inches	6 by 8	Two	Handhole
10 inches	10 by 12	Two	One hand and sight
12 thru 16 inches	12 by 16	Two	Two hands and head sight
Greater than 16 inches	16 by 24	Three	Body entry

- c. Provide sufficient sealant for application between the door frame and duct for installations in ductwork with seal Classes A and B.

- L. Spin-in Fittings: Straight pattern sheet metal spin-in fitting with 45-degree scoop designed for connection to sheet metal ductwork. Assemble using spot welds or rivets. Button punch fabrication is prohibited. Provide a specified balancing damper in the ductwork immediately downstream of each spin-in fitting.

M. Airflow Stations:

1. Acceptable Manufacturers: Air Monitor or Ebtron.
2. General Description: Velocity pressure averaging station with multipoint VP sensing elements, maximum 36 square inches per probe, and multipoint static pressure sensing elements, maximum 24-inch spacing on sides, minimum of four. Duct centerline connection to pitot grid.
3. Construction: Tubular or honeycomb air straighteners to provide uniform flow at sensing elements; copper pitot tubes.

4. Static Pressure Drop: Maximum 0.15-inch WC at 2,000 fpm for assembly.
 5. Fan Discharge Monitoring: Provide units suitable for installation mounting downstream of fans when shown in that location.
- N. Backdraft Damper :
1. Acceptable Manufacturers:
 - a. American Warming and Ventilating.
 - b. Ruskin.
 - c. Safe-Air of Illinois.
 2. Description:
 - a. Commercial-quality, multi-blade, parallel-action, counterbalanced backdraft dampers of 16-gauge GS or extruded aluminum with center-pivoted blades of maximum 6-inch width with felt or flexible vinyl-sealed edges, linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin.
 - b. Gravity backdraft dampers smaller than 18 by 18 inches furnished with air-moving equipment may be the air-moving equipment manufacturer's standard construction.
 3. Ratings: 3,500-fpm maximum velocity, 1-inch WC backpressure, set to relieve above 0.02-inch WC differential pressure.
- O. Fire Dampers for Duct Mounting :
1. Acceptable Manufacturers:
 - a. Ruskin.
 - b. Air Balance, Inc.
 2. Description: Curtain type, UL-labeled assembly with frame, interlocking blades, and 165-degree F rated fusible link. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades stored out of the airstream.
 3. Provide assemblies rated to maintain the integrity of the rated construction in which the damper be installed.
 4. Select thin-line dampers with nominal 2-inch-thick frame for installation in walls between or behind grilles.
 5. Select static or dynamic damper according to the system operation.
 6. Corrosive Environments: Fabricate dampers exposed to corrosive environments from Type 316 SS.
- P. Sheet Metal Plenums: Fabricate from minimum 18-gauge metal of the same material as the ductwork, braced with steel framing for rigidity. Provide man-access doors for plenums size 6 feet or greater in height.
- Q. Louver Blank-Off Sections: Fabricate from 20-gauge galvanized steel sheets lined with sound attenuation material as specified in Section 23 29 00, Ductwork Insulation. Install airtight attachment to louver in such a manner as to allow easy removal. Prime and paint the outside face of blank-off sections with two coats of flat black exterior paint.
- R. Contractor-Fabricated Gooseneck:
1. Materials: Minimum 18-gauge galvanized steel.
 2. Accessories: Minimum 12-inch-high curb base where size exceeds 9 by 9 inches.

2.5 DUCT HANGERS AND SUPPORTS

- A. General:
 - 1. Provide duct hanger and support material gauges to comply with details on the Drawings. Where details are not provided, comply with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - 2. Suspension material may be threaded rod, metal strap, structural shapes, or strut material; however, the use of strap is limited to inaccessible areas or those accessed through a ceiling. The use of wire as suspension material is prohibited.
- B. Upper Attachments:
 - 1. Concrete Construction:
 - a. Cast-in-place inserts as specified in another division of work are acceptable.
 - b. Expanding concrete anchors as specified in another division of work may be used.
 - c. The use of powder-actuated fasteners is prohibited without prior written consent by the Owner.
 - 2. Steel Construction:
 - a. Acceptable Manufacturers:
 - 1) Grinnell.
 - 2) B-line Inc.
 - b. Support ductwork from structure or supplementary steel, utilizing beam clamps designed for the intended service. Support from metal decks above is prohibited. Provide supplementary steel as detailed and as required.
- C. Trapezes: Utilize structural steel shapes or strut material. Separate dissimilar ducts and support materials with 1/16-inch rubber sheet.
- D. Support Frames: Structural steel shapes or strut frames for support of ductwork, accessories, and HVAC system components with nuts, bolts, fittings, etc., compatible with the frame material.

PART 3 - EXECUTION

3.1 FABRICATION AND INSTALLATION

- A. General:
 - 1. Duct sizes shown on the Drawings are inside duct dimensions and represent the net-free dimensions of the duct.
 - 2. Install the entire duct system with a minimum number of bends and transitions.
 - 3. Seal nonwelded joints with a specified chemical-resistant mastic sealant while joining.
 - 4. Install additional reinforcement to preclude ballooning or breathing of ducts.
- B. Purchased Components: Install ductwork components, such as Duct-Mate, etc., and accessories in accordance with the manufacturers' written instructions.

- C. Joints:
 - 1. Assemble round sections using couplings with duct sealer mastic applied to inside and outside of section. After applying mastic, push sections together with 1-inch minimum overlap. Apply a coat of duct sealer mastic over joint and coupling.
 - 2. At the Contractor's option, sections may be assembled with joints brazed or welded.
- D. Branch Takeoffs:
 - 1. Provide takeoffs to terminal units to be the same free area as terminal unit inlet or as shown, whichever is larger.
 - 2. Connect rigidly to terminal unit inlet without flexible duct.
- E. Splitter Dampers: Installation of splitter dampers is restricted to only those locations shown on the Drawings.
- F. Balancing Dampers:
 - 1. Install where shown and where required. Install quadrants or regulators as specified, leaving dampers locked wide open.
 - 2. Add or remove balancing dampers at the direction of the Owner based on recommendations by the air balancing firm for the necessary control of air in ducted systems.
- G. Turning Vanes: Install in 90-degree miter elbows.
- H. Extractors: Install above duct-mounted diffusers, behind sidewall supply grilles and registers, where shown.
- I. Flexible Connectors: Make connections to fans and other rotating equipment using flexible connectors with 2-inch minimum clearance between casing and ductwork. Flexible connectors are not required on internally spring-isolated units equipped with internal flexible connectors unless shown on Drawings.
- J. Ducts Through Walls and Floors:
 - 1. Caulk non-fire-rated openings with Minnesota Mining and Manufacturing (3M) Company, 3M butyl sealer.
 - 2. Seal openings through fire-rated partitions with fire sealants as specified in Section 07 90 00 – Joint Protection.
 - 3. Attach sheet metal collar tightly and neatly to duct to cover exposed openings.
- K. Rectangular Ducts Exposed to Weather:
 - 1. Provide ducts greater than 30 inches in width with 1-1/2-inch standing seams. The alternate use of a sheet metal pitched roof may be proposed, but approved by the Owner prior to fabrication or installation.
- L. Spin-in Fittings:
 - 1. The use of spin-in fittings is acceptable only in supply ductwork of 2 inches WC and lower pressure class.
 - 2. Install at branch takeoffs to outlets.

- M. Connections to Equipment:
 - 1. Install flanges to match those of connecting factory-fabricated equipment.
 - 2. Make transitions in ductwork from rectangular to round or to accommodate the sizes of factory-fabricated equipment (e.g., coils and dampers) using tapered ducts, not by safeing.
- N. Duct Access Doors: Provide duct access doors for inspection and maintenance at each fire damper, smoke or ionization detector, electric duct heater, coil, filter, humidifier, automatic damper, fan plenum, and elsewhere as indicated.
- O. Access Doors Through Building Construction:
 - 1. Provide access doors through building construction under work of this Section.
 - 2. Provide ceiling access doors adjacent to each duct-installed devices requiring inspection, adjustment, or maintenance.
 - 3. Provide wall access doors for access to duct-installed devices requiring inspection, adjustment, or maintenance.
- P. Backdraft Dampers:
 - 1. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
 - 2. Provide duct access doors for checking operation and maintenance.
- Q. Painting:
 - 1. Paint duct stackheads behind diffusers, registers, and grilles with primer and two coats of flat black paint.
 - 2. Paint exterior exposed ductwork and supports with primer and two coats of exterior flat enamel paint in accordance with Section 09 91 26 - Painting Building.
- R. Vibration Isolators:
 - 1. Provide vibration isolation in accordance with Section 23 24 00 – Vibration Isolation, and as detailed on the Drawings.

3.2 INSTALLATION, HVAC FLEXIBLE DUCTWORK

- A. Applied Location:
 - 1. Use of flexible ductwork is acceptable at connections to supply and return diffusers only where shown on the Drawings.
- B. Installation:
 - 1. Make connections at ends using Panduit strap, using Panduit installation tool, and a minimum of two wraps of duct tape. Install the strap between the rolled bead on the duct collar and the duct or diffuser.
 - 2. Suspend center spans from structure above at maximum 6-foot centers. Use with 1-inch-wide galvanized steel strap with single loop at top and 1-1/2-inch galvanized sheet metal saddles with smooth edges under duct.
 - 3. Suspending duct by laying it on the ceiling is prohibited.
 - 4. Avoid reducing the free area of the duct by crimping. Avoid bends in excess of 90 degrees.

3.3 DUCT HANGERS AND SUPPORTS

A. General Support Locations:

1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections, and the first branch elbows after nested splits.
2. Locate hangers of ducts penetrating walls or partitions as though the walls will contribute no support to the duct.
3. Install hangers in pairs on exact opposite sides of duct. Install duct supports from floors and walls when necessary.
4. Maintain hanger spacing intervals not greater than the specified maximums.
5. Install hangers at the midpoint of small- and medium-sized (less than 10 square feet) horizontal-vaned square elbows. On wide-vaned square elbows, install additional hangers at maximum allowable intervals (or less) measured along the heel lines of the elbows.
6. Provide a set of hangers at the midpoint of small- and medium-sized horizontal radius elbows with greater than 20-degree offset. Install one or more supplementary hangers along the inside and outside arcs of large-radius elbows of angle whenever the lengths of these arcs exceed the maximum hanger spacing length for that duct size.
7. Provide at least one set of hangers for short duct branches 3 feet or less in length.
8. Provide each duct riser with a minimum of two supports completely spanning the shaft opening at each floor. One pair of supports may be used to support more than one duct riser, provided that the strength of the supports is increased appropriately, and proper additional supplementary steel is used at the extra risers.
9. Support duct risers located between floors that are more than 15 feet high at each floor and halfway points between floors. The distance between intermediate supports on very high floors do not exceed 12 feet for round ducts or 10 feet for rectangular ducts (intermediate hangers may be supported from an adjacent wall or hung by rods from supports on the floor above).
10. Provide one or more sets of hangers for equipment in duct runs, such as heating coils, air terminal units, mixing boxes, etc., as recommended by their manufacturers.

B. Specific Support Locations – Locate Duct Hangers:

1. Approximately 2 to 24 inches from flexible connections of fans.
2. Approximately 2 to 24 inches from the outlets or flexible connections of terminal units or mixing boxes.
3. Approximately 12 to 36 inches from the main duct to the first hanger of long branch ducts.
4. Approximately 2 to 12 inches from the ends of branch ducts and linear diffuser plenums.
5. Approximately 2 to 24 inches from fire damper breakaway joints.
6. Approximately 2 inches to half the duct width, plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn. The heavier the duct, the closer the hanger to the centerline of the elbow.

7. Approximately 2 inches to half the duct width, plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high. Diameters of hanger rods of heavy offsets increase proportionately. The heavier the duct, the closer the hanger to the centerline of the elbow.
 8. Approximately one-eighth of the arc in from the ends of bottom and top radius elbows of vertical offsets longer than 8 feet. Short vertical offsets require hangers at the bottom elbow. Likewise, sloping offsets need at least one set of hangers at their lower-radius elbow. Fasten hangers on sloping or arched surfaces to ducts to prevent slippage.
 9. Approximately 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.
 10. Approximately 6 to 12 inches from one side of walls or partitions penetrated by ducts.
- C. Support Spacing – Maximum Permitted Hanger Spacing:
1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.
 2. Ducts with areas from 4 to 10 square feet may have their hangers spaced not more than 6 feet apart.
 3. Ducts with areas over 10 square feet may have their hangers located up to 4 feet apart.
- D. Support Method:
1. Support low ductwork from floors or other steel structures acceptable to the Owner using struts or structural steel shapes or bars. Where possible, maintain 6 inches clear between the bottom of the duct and the supporting structure.
 2. Support ductwork suspended from overhead using trapeze supports for rectangular ducts or straps for round ducts with the hanger strap wound completely around the duct. Use threaded rod for support from above.
 3. Use of sheet metal screws for attaching support straps to ducts is prohibited.
 4. Trim support material to minimum length after elevation is adjusted.

3.4 TEST AND ADJUST

- A. Pressure Testing of HVAC Ductwork:
1. Description:
 - a. Prior to connection to equipment and before applying insulation, perform a dynamic pressure test on HVAC ductwork systems using a high-pressure blower with a calibrated orifice and manometer. Provide necessary blowers, gauges, connections, and similar items required to perform the tests.
 - b. Repair leaks and retest until stipulated results are achieved.
 - c. Advise the Owner 48 hours in advance of each test. Failure to so notify will require test to be rescheduled.

2. Testing Requirements:

Pressure Class	Seal Class	Test Pressure	Maximum Loss Percent *
2 inches WC	A	2 inches WC	0.5
	B	2 inches WC	1.0
	C	2 inches WC	2.0
3 inches WC	A	3 inches WC	0.5
	B	3 inches WC	1.0
4 inches WC and above	A	6 inches WC	0.5

*Percent of rated airflow.

3.5 ADJUSTING AND CLEANING

- A. Cleaning of General Service Ductwork: Remove debris from general-purpose ductwork and accessories, then blow ductwork clean with air movement provided by the system fan or blower. Blow supply ductwork clean before final branch connections are made to terminal units or before terminal grilles, registers, or diffusers are installed.
- B. General Cleaning: Clean up and remove refuse material, crates, and rubbish arising from work of this Section from the premises.

3.6 SCHEDULE

- A. Fabricate portions of systems listed in 23 31 13.01 – Ductwork Schedule from sheet metal with gauge and reinforcement in accordance with SMACNA duct construction tables.

3.7 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
23 31 01-01	Shop drawings of suspended ductwork.	X	Prior to delivery
23 31 01-03	Product data for duct accessories.	X	Prior to delivery
23 31 01-04	Product data for duct materials.	X	Prior to delivery
23 31 01-05	Certificate of test approval by Owner's representative on systems within 1 week of test date.	X	Prior to delivery

END OF SECTION

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SECTION 23 31 13.01
DUCTWORK SCHEDULE

System	Specifi- cation Number	Duct Material	Pressure Class Inches WG	SMACNA Seal Class	Minimum Gauge	Design Standard	System Class	Gasket Material	Sealant Material	Pressure Test Required	Flex. Duct Type	Remarks
Supply Air ductwork	23 31 01	GS	4	A	20		N/A	STD	STD	Yes		
Return Air ductwork	23 31 01	GS	2	A	20		N/A	STD	STD	Yes		
OA ductwork	23 31 01	GS	2	B	20		N/A	STD	STD	No		
General EA ductwork	23 31 01	GS	2	B	20		N/A	STD	STD	No		
Ductwork downstream of terminal units	23 31 01	GS	2	C	Code		N/A	STD	STD	No		
Toilet Room exhaust ductwork	23 31 01	GS	Minus 2	B	Code		N/A	STD	STD	Yes		
Lab exhaust ductwork	23 31 01	316 SS	Minus 4	A		NFPA 91				Yes		Note 1D

Notes for Ductwork with Section 23 31 13.01:

- 1A: Seal joints and seams watertight and slope ductwork toward the fan.
- 1B: Seal joints and seams watertight and slope ductwork toward the air inlet.
- 1D: Provide die-stamped converging flow type fittings. Seal joints and seams with a chemical-resistant mastic, rivet butt joints with a minimum of eight pop rivets or provide continuous welds. Provide a removable, screwed, gasketed cleanout access door at each elbow and at 25-foot intervals along straight runs.
- 1E: Provide gasketed access doors.
- 1F: Fabricate with continuous external welded joints. Slope to prevent grease accumulation. Provide long radius elbows.

SECTION 23 33 46

FLEXIBLE DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for general purpose flexible ductwork used to convey hot and cold air in normal heating, ventilating, and air conditioning systems.

1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this section.

1.3 QUALITY ASSURANCE

- A. Laboratory Classification:
 - 1. Conform to requirements for Class 1 air duct connectors when tested in accordance with UL 181.
 - 2. Outer jacket perm rating 0.1 grains per square foot, per hour, per inch of mercury when tested in accordance with ASTM E96, Procedure A.
 - 3. Insulating materials maintain a C factor of 0.23 or less.
- B. Fire Hazard Classification: Independent or composite fire hazard classification (flame spread/smoke developed) of 25/50 or less when tested in accordance with NFPA 255 or other industry accepted standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexmaster USA, Inc.
- B. Genflex.

2.2 HIGH PRESSURE FABRIC FLEXIBLE DUCTWORK

- A. Construction: Factory fabricated assembly trilaminate of aluminum foil, fiberglass, and polyester, mechanically locked, without adhesives, into a formed aluminum helix on duct's outside surface.
- B. Perm Rating: 0.02 grains per square foot, per hour, per inch of mercury.
- C. Material Properties: High tear strength, and properties to resist temperature change, mildew, and age hardening.

- D. Required Material Ratings:
 - 1. Positive Pressure: 12-inch w.g. minimum.
 - 2. Negative Pressure: 5-inch w.g. through 16-inch diameter.
 - 3. Operating Temperature Range: -20 degrees F to 250 degrees F.

2.3 HIGH PRESSURE ALUMINUM FLEXIBLE DUCTWORK

- A. Construction: Fabricated from dead soft aluminum sheet, spiral wound into a tube and spiral corrugated to provide strength and flexibility, with triple mechanical lock construction to form a continuous, secure, airtight joint. Use no adhesives in fabrication.
- B. Required Material Ratings:
 - 1. Temperature Range: -60 degrees F to +600 degrees F.
 - 2. Maximum Operating Pressure: 12-inch w.g. positive.

2.4 LOW PRESSURE FLEXIBLE DUCTWORK

- A. Construction: Factory fabricated assembly of trilaminate of aluminum foil, fiberglass, and polyester, mechanically locked, without adhesives, into an aluminum helix formed on duct's outside surface.
- B. Perm Rating: 0.02 grains per square foot, per hour, per inch of mercury.
- C. Material Properties: High tear strength, and properties to resist temperature change, mildew, and age hardening.
- D. Required Material Ratings:
 - 1. Positive Pressure: 12-inch w.g. minimum.
 - 2. Negative Pressure: 5-inch w.g. through 16-inch diameter, 1-inch w.g. for 18-inch and 20-inch diameter.
 - 3. Operating Temperature Range: -20 degrees F to 250 degrees F.

2.5 INSULATION

- A. Factory wrapped blanket of fiberglass insulation.
- B. C factor of 0.23 or less.
- C. Encased in fire retardant polyethylene or reinforced metalized and protective vapor barrier with perm rating of not over 0.1 grains per square foot, per hour, per inch of mercury.
- D. UL rated as an air duct material.

2.6 MISCELLANEOUS COMPONENTS

- A. Spin Collar Fittings for Sheet Metal: Connect flexible ductwork to metallic duct system with factory fabricated fittings as described below:
 - 1. ASTM A653 G90 Coating Designation galvanized steel construction.
 - 2. Adjustable butterfly dampers with spring loaded, refractable bearing and positive locking regulator.
 - 3. Fittings include a die-formed, locking groove to ensure constant fit and ease of installation.
 - 4. Acceptable Products and Manufacturers:
 - a. "Series SM-1D" by Genflex or "FLD" by Flexmaster for sheet metal duct system without duct lining.
 - b. "Series SM-1DG" by Genflex for duct system with duct lining.
- B. Duct and Sleeve Adhesives: Foster #32 14 (for high pressure only).
- C. Tape:
 - 1. Width: 2 inches.
 - 2. Flexible Ductwork with Plastic Outer Skin: Arno #520.
 - 3. Flexible Ductwork with Aluminized Outer Skin: Arno #442.
- D. Clamps: 1/2-inch-wide positive locking, steel bands or self-locking nylon clamp.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install proper type of flexible ductwork in accordance with applicable standards, manufacturer's recommendations, and details shown on Drawings.
- B. Make connections to systems with type fittings specified for specific application.
- C. Install duct in fully extended condition free of kinks and sags.
- D. Maximum duct length not exceeding 5'-0".
- E. Where duct requires supports, suspend on 36-inch centers.
- F. Make splices and connections with 2-inch-wide tape, duct adhesives, and 1/2-inch-wide positive locking bands used in conjunction with factory supplied sleeves, couplings, or spin collar fittings.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
23 33 46-01	Product Data including: • Duct designation number. • Type of flexible ductwork. • Manufacturer's name and product identification name or number. • Minimum and maximum temperature limits (°F). • Minimum negative and maximum positive static pressure limits (inches w.g.). Description of adhesives and tapes: • Description of insulation: - o Type. - o Density. - o Thickness. - o Thermal conductivity. - o Description of exterior facing. - o Code compliances for each duct type. - o Installation recommendations.	X	Prior to delivery

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Centrifugal fans.
 - 2. Upblast centrifugal roof fans.
 - 3. Lab Exhaust.
- B. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. Air Movement and Control Association International, Inc:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- D. ASTM International:
 - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- E. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. Underwriters Laboratories Inc.:
 - 1. UL 705 - Power Ventilators.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300 ,and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 WARRANTY

- A. Furnish five-year manufacturer's warranty for fans. Fan belts shall be clearly identified and labeled as to the equipment that it fits.

1.10 EXTRA MATERIALS

- A. Furnish two sets of belts for each fan.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

- A. Manufacturers:
 - 1. Greenheck Corp.
 - 2. Loren Cook Company
 - 3. Penn Ventilation
- B. Wheel and Inlet:
 - 1. Backward Inclined: Steel construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
- C. Housing:
 - 1. Steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
 - 2. Factory finish before assembly to manufacturer's standard.
 - 3. Bolted construction with horizontal flanged split housing.
 - 4. Fabricate plug fans without volute housing, in lined steel cabinet.
- D. Bearings and Sleeves:
 - 1. Bearings: Pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9 L-10 life at 50,000 hours.
 - 2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
 - 3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
 - 4. Belt Guard: Fabricate to SMACNA Standard; 0.106-inch thick, ¾-inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- E. Accessories:
 - 1. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
 - 2. Inlet/Outlet Screens: Galvanized steel welded grid.
 - 3. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
 - 4. Scroll Drain: 1/2-inch steel pipe coupling welded to low point of fan scroll.

2.2 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers:
 - 1. Acme Engineering and Manufacturing Corp.
 - 2. Greenheck Corp.
 - 3. Loren Cook Company
 - 4. Penn Ventilation
- B. Fan Unit: Upblast type. V-belt drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Totally enclosed fan cooled.
- E. Roof Curb: 16-inch high of galvanized steel construction with continuously welded seams, built-in cant strips, 1-inch insulation and curb bottom hinged curb adapter, and factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 4 enclosure.
- G. Accessories:
 - 1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
 - 2. Fan speed controller.

2.3 LAB EXHAUST FAN EF-1&2

- A. Base fan performance at standard conditions (density 0.075 Lb/ft³).
- B. Fans selected shall be capable of accommodating static pressure and flow variations of $\pm 15\%$ of scheduled values.
- C. Each fan shall be belt driven in AMCA arrangement 9 according to drawings.
- D. Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
- E. Fasteners exposed to corrosive exhaust shall be 316 stainless steel.
- F. Curb cap shall be 316 stainless steel.
- G. Fan assemblies that use flexible connectors that can fail, and cause loss of laboratory containment shall not be acceptable.

- H. Fan assembly shall be designed for a minimum of 125-mph wind loading, without the use of guy wires.
- I. Motor cover shall be hinged with removable side panels for ease of maintenance to allow the servicing of the motor and drive.

2.4 CORROSION RESISTANT COATING

- A. All fan and system components (fan, nozzle, wind band and plenum) shall be corrosion resistant coated with a two part electrostatically applied and baked, sustainable, corrosion resistant coating system. Standard finish color to be gray. The coating system, a total thickness of up to 6 mils, and shall not be affected by the UV component of sunlight (does not chalk), and corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000-hour ASTM B117 Salt Spray Resistance.

2.5 FAN HOUSING AND OUTLET

- A. Fan housing shall be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
- B. Fan housing shall be bifurcated, allowing all drive components, including the motor, to be serviced without contact of the contaminated airstream. Must be manufactured of welded steel for corrosion resistant coating. No uncoated metal fan parts will be acceptable.
- C. A multi-stage air induction discharge nozzle shall be supplied by the fan manufacturer be designed to efficiently handle an outlet velocity of up to 7000 FPM. The multi-stage nozzle shall induce ambient air up to 270% of fan capacity.
- D. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.
- E. An access door shall be supplied for impeller inspection and service.
- F. Fan assembly shall be AMCA type C spark resistant construction minimum or as noted on the schedule.

2.6 FAN IMPELLER

- A. Fan impeller shall be mixed flow design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.
- B. Fan impeller shall be manufactured of welded and coated steel.
- C. Vacuum Seal: Fan impeller shall include a secondary fan blade located on the impeller back plate. This secondary impeller shall create a negative pressure at the shaft opening; preventing hazardous or toxic exhaust fumes from escaping through the housing shaft opening. Mechanical shaft seals that wear out and need to be replaced or seal systems that use hoses or tubes that can leak, are not acceptable.

2.7 BYPASS AIR PLENUM

- A. A bypass air plenum shall be provided as shown on drawings. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weather hood and bird screen.
- B. The plenum shall be constructed of welded and coated steel for corrosion resistant coating.
- C. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings.
- D. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be permitted.
- E. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of stainless steel. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 304 stainless steel jamb seals and the blades shall have polymer edge seals. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.
- F. Fan isolation damper(s) shall be parallel-blade design, airfoil design, fabricated of stainless steel. Damper(s) shall be coated up to 4 mils of chemically resistant Hi-Pro Polyester resin, electrostatically applied and baked. Isolation damper(s) shall have stainless steel damper rods, stainless steel sleeved bearings, stainless steel jamb seals and the blades shall have polymer edge seals. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.
- G. Isolation damper actuator(s), if scheduled shall be factory mounted and shall be wired to a step-down transformer. Actuator and transformer are located in a weatherproof enclosure.

2.8 BYPASS AIR PLENUM CURB

- A. Exhaust system manufacturer shall supply a structural support curb for the plenum.
- B. Curb shall be fabricated of a minimum of 12-gauge corrosion-resistant coated steel and structurally reinforced.
- C. Curb shall be insulated.
- D. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2.9 FAN MOTORS AND DRIVE

- A. Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, TEFC with a 1.15 service factor. A factory mounted NEMA 3R lockable disconnect switch shall be provided for each fan.
- B. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components. Drive arrangement shall be AMCA arrangement #9.
- C. Drive belts and sheaves shall be sized for 200% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
- D. Fan shaft to be turned and polished of stainless steel.
- E. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 200,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use setscrews shall not be acceptable.
- F. All shaft bearings and non-permanently lubricated motors shall have stainless steel braided extended lube lines with zerk fittings.
- G. Belt drive motors shall have ventilated motor cover. Motor cover shall be hinged with removable side panels for ease of maintenance to allow the servicing of the motor and drive(s).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

- A. Secure roof with stainless steel lag screws to roof curb structure.
- B. Install backdraft dampers on inlet to roof exhaust fans and gravity ventilators used in relief air applications.
- C. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- D. Install safety screen where inlet or outlet is exposed.
- E. Pipe scroll drains to nearest floor drain.

F. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

A. Section 01 77 10 – Closeout Procedures: Requirements for cleaning.

B. Vacuum clean coils and inside of fan cabinet.

3.5 DEMONSTRATION

A. Demonstrate fan operation and maintenance procedures.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 77 10 – Closeout Procedures: Requirements for protecting finished Work.

B. Do not operate fans until ductwork is clean, filters in place, bearings lubricated, and fan has been tested run under observation.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable volume terminal units.

1.2 REFERENCES

- A. American Refrigeration Institute:
 - 1. ARI 880 - Air Terminals.
 - 2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

- A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, heating coil capacity and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.
- B. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.5 QUALITY ASSURANCE

- A. Test and rate air terminal unit's performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 COORDINATION

- A. Coordinate Work with Section HVAC Instrumentation and Controls Spec.

1.9 WARRANTY

- A. Furnish one-year manufacturer warranty for air terminal units.

PART 2 - PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Environmental Technologies, Inc.
 - 2. Krueger
 - 3. Price.
 - 4. Titus
 - 5. Trane.
- B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls, and electric heating coils.
- C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

- D. Basic Assembly:
 - 1. Casings: Minimum 22 gage galvanized steel.
 - 2. Lining: Minimum 1/2-inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
 - 3. Plenum Air Outlets: S slip-and-drive connections.
- E. Basic Unit:
 - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
 - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1-inches inlet static pressure.
 - 3. Mount damper operator to position damper normally open.
- F. Electric Heating Coil:
 - 1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
 - a. Primary and secondary over-temperature protection.
 - b. Minimum airflow switch.
 - c. Magnetic contactor for each step of control.
- G. Automatic Damper Operator:
 - 1. Electric Actuator: 24 volt .
- H. Thermostat: Electronic type with appropriate mounting hardware.
- I. Sequence of Operation: Refer to drawings.

2.2 PARALLEL FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Environmental Technologies, Inc.
 - 2. Krueger
 - 3. Price.
 - 4. Titus
 - 5. Trane.
- B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.040-inch- thick galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 - 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 5. Fan: Forward-curved centrifugal, located at plenum air inlet.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 2. Damper Position: Normally open.
- E. Velocity Sensors: Multipoint array with velocity sensors.
- F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 2. Type: Electronically commutated motor. Motor speed controller with infinitely adjustable electronic controls.
 3. Fan-Motor Assembly Isolation: Rubber isolators.
 4. Enclosure: Open drip proof.
 5. Enclosure Materials: Rolled steel.
 6. Efficiency: Premium efficient.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Material: Pleated cotton-polyester media having 90 percent arrestance and 8 MERV.
 2. Thickness: 1 inch.
- H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. Location: Discharge.
 2. Stage(s): 3.
 3. SCR controlled.
 4. Access door interlocked disconnect switch.
 5. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 6. Nickel chrome 80/20 heating elements.
 7. Airflow switch for proof of airflow.
 8. Fan interlock contacts.
 9. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 10. Mercury contactors.
 11. Pneumatic-electric switches and relays.
 12. Magnetic contactor for each step of control (for three-phase coils).

- I. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 - 1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 - 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - 3. Disconnect Switch: Factory-mounted, fuse type.
- J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- K. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 - 1. Damper Actuator: 24 V, powered open, powered close.
 - 2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit.
 - 3. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 01.
- B. Install ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Support air terminal units connected by flexible duct independently of flexible duct.
- E. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.

3.3 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to the scheduled minimum flow.

END OF SECTION

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SECTION 23 74 10

PACKAGED ROOFTOP AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Heat-pump refrigeration components.
 - 3. Hot gas reheat.
 - 4. Electric-heating coils.
 - 5. Gas furnace.
 - 6. Economizer outdoor- and return-air damper section.
 - 7. Integral, space temperature controls.
 - 8. Roof curbs.
- B. Related Sections include the following:
 - 1. Section 237333.16 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.
 - 2. Section 237339 "Indoor, Direct-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air without heat exchangers.
 - 3. Section 237433 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which RTUs will be attached.
 - 2. Roof openings
 - 3. Roof curbs and flashing.
- B. Field quality-control test reports.
- C. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each unit.

1.8 QUALITY ASSURANCE

- A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than **five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
1. Exterior Casing Thickness: 0.052 inch thick.
- C. Inner Casing Fabrication Requirements:
1. Inside Casing: Galvanized steel, 0.034 inch.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071, Type I.
 2. Thickness: 1/2 inch.
 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.

- 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple both sides of drain pan.
 - 3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.2 FANS

- A. Direct-Driven Supply-Air Fans: Double width, backward inclined, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- D. Relief-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.
- E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
- F. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.3 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Coil Split: Interlaced.
 - 4. Baked phenolic coating.
 - 5. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1.
- B. Outdoor-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.

2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 3. Baked phenolic coating.
- C. Hot-Gas Reheat Refrigerant Coil:
1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 3. Baked phenolic coating.
- D. Electric-Resistance Heating:
1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
 2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
 3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
 4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - a. Magnetic contactors.
 - b. Step Controller: Pilot lights and override toggle switch for each step.
 - c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - d. Time-delay relay.
 - e. Airflow proving switch.

2.4 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
1. Refrigerant: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Hot gas reheat solenoid valve with a replaceable magnetic coil.
 11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.5 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated upstream: 2-inch MERV 8.
 - 2. Pleated: 4-inch thick, Minimum MERV 13.

2.6 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with manual motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - 1. Damper Motor: Modulating with adjustable minimum position.
 - 2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.7 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.8 CONTROLS

- A. Basic Unit Controls:
 - 1. Control-voltage transformer.
 - 2. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Degree F indication.
 - g. Unoccupied-period-override push button.
 - h. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
 - 3. Wall-mounted sensor with the following features:
 - a. Exposed set point.
 - b. Exposed indication.
 - 4. Unit-Mounted Annunciator Panel for Each Unit:
 - a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
 - b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.

- c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
- B. DDC Controller:
 - 1. Controller shall have volatile-memory backup.
 - 2. Refer to sequence of operations on drawings.
- C. Interface Requirements for HVAC Instrumentation and Control System:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - 3. Provide BACnet or LonWorks compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Monitoring supply fan start, stop, and operation.
 - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
 - d. Monitoring occupied and unoccupied operations.
 - e. Monitoring constant and variable motor loads.
 - f. Monitoring variable-frequency drive operation.
 - g. Monitoring cooling load.
 - h. Monitoring economizer cycles.
 - i. Monitoring air-distribution static pressure and ventilation air volume.

2.9 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- C. Low-ambient kit condenser fans for operation down to 35 deg F.
- D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- E. Coil guards of painted, galvanized-steel wire.
- F. Hail guards of galvanized steel painted to match casing.
- G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.10 ROOF CURBS

- A. Roof curbs with vibration isolators.
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1-inch.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 24 inches.
- D. Wind Restraint: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations.
 2. Comply with requirements for vibration isolation devices.
- B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts.", ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

- C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.

5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Inspect operation of barometric relief dampers.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Adjust fan belts to proper alignment and tension.
16. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
17. Inspect and record performance of interlocks and protective devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and fire stat alarms.
28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

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SECTION 23 74 13

PACKAGED DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for packaged dedicated outdoor air units.

1.2 PERFORMANCE REQUIREMENTS

- A. Capacities and characteristics as specified on Equipment Schedules on Drawings.
- B. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”
- C. Cabinet Thermal Performance:
 - 1. Maximum Overall U-Value: 0.08 Btu/h per sq. ft per deg F (nominal R-13)
 - 2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- D. Cabinet Surface Condensation:
 - 1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 - 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall compromise the structural integrity of the cabinet.
- E. Maximum Cabinet Leakage: 1% or less of total supply air flow at a pressure rating equal to the fan shut-off pressure.
- F. Cabinet Deflection Performance:
 - 1. Walls and roof deflection shall be within 1/240 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
 - 2. Floor deflections shall be within 1/360 of the span considering the worst-case condition caused by the following:
 - a. Service personnel.
 - b. Internal components.
 - c. Design working pressure defined for the walls and roof.
- G. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Certify in accordance with AHRI 430. Use current adopted edition.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Ship with firmly attached labels that indicate name of manufacturer, model number, and chiller serial number.
- B. Storage:
 - 1. Protect from physical damage. Leave factory shipping covers in place until unit is installed.
 - 2. Store in safe, dry location.
- C. Handling:
 - 1. Receive and inspect for damage and shortage at Project site.
 - 2. Unload using methods which minimize risk of damage.
 - 3. Use padded or strap slings.
 - 4. Lift only at points recommended by manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil electric heaters, exhaust fans, and unit controls.
- B. Ship large units in subsections with bolted, flanged casing connections.
- C. Assemble and factory test unit.
- D. Galvanize components as follows:
 - 1. Steel Sheet Components: ASTM A653, G210 Coating Designation.
 - 2. Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip: ASTM A123.

2.2 ACCEPTABLE MANUFACTURERS

- A. AAON
- B. Valent
- C. Or equal.

2.3 BASE

- A. Manufactured of structural steel members, electrically welded to form rigid equipment mounting structure. Formed sheet metal structural members not acceptable.
- B. Overhang roof curb for positive water drainage.
- C. Fabricated recess with continuous surface to seat on roof curb, providing positive, weathertight seal.

2.4 CABINET

- A. General: Designed and built specifically for outdoor installation; provide leak-proof construction for specified pressures.
- B. Construction: double wall with G90 galvanized steel, impact resistant, rigid polyurethane foam panels.
- C. Exterior Casing Material: Galvanized steel with paint finish.
- D. Interior Casing Material: Galvanized steel.
- E. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- F. Base Rails: Galvanized steel rails for mounting on roof curb or mounting on grade as indicated.
- G. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- H. Floor: galvanized steel step-in/walk-in platforms inside access doors to protect insulation and facilitate maintenance.
- I. Roof Panels:
 - 1. Galvanized, pitched for drainage, overlapping side panels on four sides.
 - 2. Gasket and secure to wall panels with zinc coated steel screws.
 - 3. Gasket and bolt together roof panel section joints with "C" clip over joints for additional weather protection.
 - 4. Insulate to prevent insulation erosion into airstream.
- J. Drain Pan: Provide double wall insulated drain pan under coil and fan section fabricated of stainless-steel sheets. Continuously weld seams and joints to provide watertight pan. Provide insulated "P" trap for proper condensate drainage.

- K. Access Doors: Minimum 2'-0" wide x 5'-0" high, gasketed, hinged, double wall with industrial style latches and insulation retainers around door frames to prevent incidental damage to insulation when using access doors. Provide rain drip lips above access doors.
- L. Cabinet Insulation:
 - 1. Type: Closed cell foam insulation.
 - 2. Thickness: 2 inches.
 - 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage or thermal bridging when applied as recommended by manufacturer.
 - 5. Insulation shall not be in contact with air stream.
- M. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.5 RETURN AIR SAFETY GRATE

- A. Provide to protect service personnel from falling into return air duct.

2.6 FANS

- A. Wheel: Double width, double inlet centrifugal type with backward inclined or airfoil blades.
- B. Forward Curved or Backward Inclined Fan Type: Centrifugal, statically and dynamically balanced.
 - 1. Fan Wheel Material: Galvanized steel, mounted on solid-steel shaft.
 - 2. Bearings: Pillow-block bearings rated L₅₀ for 200,000 hours and having external grease fittings. Extend lube lines for bearings to facilitate lubrication from one side without removal of belt guard.
- C. Service Factor for Belt Drive Applications: Multiple V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.

2.7 FAN MOTORS

- A. Type: NEMA Design B, premium efficiency, squirrel cage, induction type, designed for continuous duty, across line starting, and service factor of 1.15. Provide with electrical characteristics as indicated in Equipment Schedules on Drawings.
- B. Enclosure: Totally Enclosed. Cast Iron Material.
- C. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.
- D. Provide variable frequency drives. Variable frequency drives shall be factory wired and mounted in the unit.

2.8 BELT GUARDS

- A. Fabricate of steel sheets and finish compatible with unit casing.
- B. Design to:
 - 1. Enclose moving parts.
 - 2. Be easily removable.
 - 3. Comply with OSHA requirements.

2.9 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Stainless steel.
- C. Tube Material: Copper.
- D. Tube Header Material: Copper.
- E. Fin Material: Aluminum
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested at 400 psig with air underwater.
- H. Refrigerant Coil Capacity Reduction: Circuit coils for row interleaved control.
- I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- J. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.10 REFRIGERATION SYSTEMS

- A. R-410A refrigerant. Expansion valve type refrigerant flow control, automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both high pressure and low-pressure sides, and factory installed replaceable core liquid line filter driers for each refrigeration circuit.
- B. Scroll type compressors with thermal overload protection. Isolated service compartment for compressors mounting with lockable hinged compressor access doors. Access doors shall be double wall, rigid polyurethane foam injected panels. Isolation of compressors from base pan with rubber vibration isolators.
- C. Variable capacity scroll compressor on all refrigeration circuits, capable of 10-100% capacity modulation.

- D. Hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor, and a control signal terminal for lead refrigeration circuits capable of dehumidification operation.

2.11 CONDENSERS

- A. Vertical discharge, axial flow, direct drive condenser fans.
- B. Multi-pass, aluminum microchannel tube condenser coils.
- C. Coils capable of refrigerant sub-cooling design to minimum 10F. Coils shall be hydrogen or helium leak tested.
- D. VFD driven variable speed condenser fans with condenser head pressure control. Factory provided and factory programmed VFDs for continuous fan modulation to maintain head pressure at acceptable level. Adjustable compressor lockout for cooling operation down to 35F.

2.12 ELECTRIC HEATING COILS

- A. Elements: Fin Tubular type, 80 percent nickel/20 percent chromium resistance coils, insulated by floating steel bushings.
- B. Bushings: Recessed into embossed openings, stacked into supporting brackets, spaced maximum of 4-inch centers.
- C. Thermal Cutouts: Provide for primary and secondary overtemperature protection; meet UL and NEC requirements.
- D. Frame: Galvanized.
- E. Maximum Heating Density: 55 watts per square inch.
- F. Integral Control Box:
 - 1. Location: Flush mounted on side of unit with access door.
 - 2. Contents:
 - a. Thermal cutouts.
 - b. Primary control.
 - c. Secondary control.
 - d. Sub-circuit fusing.
 - e. Airflow switch.
 - f. Fused control transformer.

2.13 DAMPERS

- A. General: Rectangular, frame-mounted, multi-blade, shaft-operated type, of galvanized steel construction.

- B. Frame: Fabricate from minimum 16-gauge galvanized steel with connecting blade linkage located out of air stream.
- C. Blades: Fabricate from minimum 16-gauge galvanized steel compatible with damper frame. Width not to exceed 6 inches operating “within” frame.
- D. Leakage:
 - 1. 4 cfm per square foot at 1.0 inches water pressure differential.
 - 2. 8 cfm per square foot at 4.0 inches water pressure differential.
- E. Mixing Box Dampers: Parallel blade, interconnecting outside and return air dampers.

2.14 FILTERS

- A. Certification: In accordance with ASHRAE 52.
- B. 2-inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4-inch standard filters.
- C. 4-inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of cooling coil.
- D. Provide clogged filter switch.
- E. Provide Magnehelic gauge mounted in the controls compartment.

2.15 ACCESS AND PLENUM SECTIONS

- A. Provide where indicated on Drawings with double-wall hinged door.

2.16 VIBRATION ISOLATORS

- A. Type: Housed, spring type with neoprene stabilizers and leveling bolts, mounted on a non-skid neoprene acoustical pad.
- B. Acceptable Manufacturer: Vibration Mountings and Controls, Inc.

2.17 INLET HOOD

- A. Provide with finish and construction matching unit casing, with high performance sine wave moisture eliminators, 2-1/4 inches minimum depth, to prevent moisture carryover into unit casing and filter bank.

2.18 LIFTING BRACKETS

- A. Factory installed to permit lifting of unit without slings.

2.19 ROOF CURB

- A. General Description: Provided by air handling unit manufacturer, with joiners, gasketing, and bolts for installation, 38 inches high, approved by National Roofing Contractors Association.
- B. Construction: Pad mount, double wall with 2" insulation. 14 Gage Galvanized steel with wood nailer factory installed. Curb with turning vanes in supply section for horizontal supply air discharge. Paint to match color of air handling unit.

2.20 ELECTRICAL REQUIREMENTS

- A. Electrical Wiring:
 - 1. Fan Motor: Wire through electrical conduit to weatherproof junction box on inside front wall of fan section. Provide flexible conduit at fan to allow for insulation.
 - 2. Lights and Receptacle: Provide heavy-duty overhead light in fan section. Wire through electrical conduit to weatherproof junction box mounted beside motor wiring junction box. Provide light switch and 115-volt receptacle in junction box. Units larger than 8 feet in width require two lights. Owner to provide single point electrical connection.

2.21 CONTROLS

- A. Controls:
 - 1. Factory installed and factory provided controller.
 - 2. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
 - 3. Controller shall be capable of stand-alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - 4. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - 5. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 - 6. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software.
 - 7. Controller shall be capable of connection with other factory installed and factory provided unit controller with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit.
 - 8. Connection between unit controllers shall be with modular cable.
 - 9. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network.

2.22 ACCESSORIES

- A. Provide safety shutdown terminal block for field installation of smoke detector(s) which shut off the unit's control circuit.

2.23 IDENTIFICATION

- A. Include unit's designation number on manufacturer's permanent nameplate.
- B. Using black paint, stencil unit's designation number on unit in location easily read from access or service areas. Provide minimum 2-inch-high numbers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Not applicable. Equipment specified in this Section will not be received, unloaded, and installed by this Section.
- B. Comply with Section 23 00 15 – Basic Equipment Installation.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
23 74 00-01	Product Data: Include: • Unit designation number. • Type of unit. • Manufacturer's name and model number. • Dimensions of unit, mounting attachments, specified accessories, and locations of service connections. • Description of fabrication materials for unit including: • Structural members. • Casing. • Insulation. • Fans. • Heating coils • Filters. • Dampers. • Description of unit motor including:	X	Prior to delivery

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
	• Manufacturer's name and model number. • Nameplate horsepower. • Efficiency (%) • Service factor. • Type enclosure. • Speed factor. • Electrical characteristics (V/Ph/Hz). • Description of unit drive package including: • Manufacturer's name and model number for sheaves and belts. • Horsepower rating. • Sheave diameters. • Bushing sizes. • Belt sizes and numbers. • Percent adjustment above and below design setpoint. • Shipping and operating weights of unit with weight distribution at support points. Fan performance curves indicating: • Air quantity. • Static pressure. • Bhp. • Efficiency. • Tip speed. • Rpm. • Sound power level (dB re 10⁻¹² watts) for each octave band. Cooling coil performance data indicating: • Air quantity. • Rows. • Fin spacing. • Air side pressure drop. • Entering air db and wb temperatures. • Leaving air db and wb temperatures. • Entering and leaving chilled water temperatures.		

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
	• Water quantity. • Water side pressure drop. Heating coil performance data indicating: • Air quantity. • Rows. • Fin spacing. • Air side pressure drop. • Entering and leaving air db temperature. • Filter data including: • Face area. • Initial and recommended final pressure drops. • Efficiency. • Damper areas and air side pressure losses. • Outside and relief air louver sizes, percent free area, and air side pressure losses. • Installation, operation, and repair instructions.		
23 74 00-02	Shop Drawings: Include: • Overall, 2-line unit layout, indicating available service areas and clearance requirements. • Elevations and sections to show clearances, methods of support, and details of installation. • Locations and sizes of openings.	X	Prior to delivery

END OF SECTION

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SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each air-handling unit.
 - 2. Gaskets: One set for each access door.
 - 3. Fan Belts: One set for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carrier
- B. LG
- C. Trane
- D. York

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Concealed Evaporator-Fan Components:
 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 2. Insulation: Faced, glass-fiber duct liner.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; with a two-position control valve.
 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: Permanent, cleanable.
9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
10. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 2 inches.
 - 3) Initial Resistance: 0.15 inches wg.
 - 4) Arrestance according to ASHRAE 52.1: 80.
 - 5) Merv according to ASHRAE 52.2: 5.
 - 6) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
 - 7) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.
11. Controls – shall be factory wired and factory installed on the air handling unit. Shall include all required controls to meet intent of Sequence of Operation described on the drawings; all safety controls and interlocks; and terminal strip for remote wired devices. Provide with required step-down transformers for single point connection.
12. Electrical – Unit shall be single point connection with motor starters. A complete wiring diagram shall be permanently attached to the inside of the panel door.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 - 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 206/110.
 - 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 - 4. Fan: Aluminum-propeller type, directly connected to motor.
 - 5. Motor: Permanently lubricated, with integral thermal-overload protection.
 - 6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
 - 7. Mounting Base: Polyethylene.
 - 8. Controls – shall be factory wired and factory installed on the air handling unit. Shall include all required controls to meet intent of Sequence of Operation described on the drawings; all safety controls and interlocks; and terminal strip for remote wired devices. Provide with required step-down transformers for single point connection. Options shall include low ambient controls and anti-short cycle timer.
 - 9. Electrical – Unit shall be single point connection with motor starters. A complete wiring diagram shall be permanently attached to the inside of the panel door.

2.4 ACCESSORIES

- A. Sequence of operation are specified on drawings.
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

- F. Drain Hose: For condensate.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units' level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
 - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 3. Comply with requirements for vibration isolation devices specified in "Vibration Controls for HVAC" Spec.
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- B. Duct Connections: Duct installation requirements are specified in "Metal Ducts" Spec. Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - D. Remove and replace malfunctioning units and retest as specified above.
 - E. Prepare test and inspection reports.
- 3.4 STARTUP SERVICE
- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
- 3.5 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

SECTION 23 81 29

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes complete VRF HVAC system(s) for Arlington Admin Building including, but not limited to the following components to make a complete operating system(s) according to requirements of indoor units relocation:
 - 1. Relocation of existing Indoor, exposed, wall-mounted and ceiling units.
 - 2. System controls if applicable to accommodate relocation of indoor units
 - 3. System refrigerant and oil.
 - 4. System condensate drain piping.
 - 5. System hydronic piping.
 - 6. System refrigerant piping.
 - 7. Metal hangers and supports.
 - 8. Metal framing systems.
 - 9. Fastener systems.
 - 10. Pipe stands.
 - 11. Equipment stands.
 - 12. Miscellaneous support materials.
 - 13. Piping and tubing insulation.
 - 14. System control cable and raceways.

1.2 DEFINITIONS

- A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
- B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.
- E. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

- F. VRF: Variable refrigerant flow.

1.3 ACTION SUBMITTALS

- A. Product data.
- B. Shop Drawings: For VRF HVAC systems.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, using input from installers of the items involved.
- B. Qualification Data:
 - 1. For Installer.
 - 2. For VRF HVAC system manufacturer.
 - 3. For VRF HVAC system provider.
- C. Product Certificates: For each type of product.
- D. Product test reports.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
3. Demonstrated past experience on five projects of similar complexity, scope, and value.
 - a. Each person assigned to Project shall have demonstrated past experience.
4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
5. Service and maintenance staff assigned to support Project during warranty period.
6. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
7. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.
 - a. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
 - b. Demonstrated past experience on five projects of similar complexity, scope, and value.

C. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

PART 2 - INDDOR UNIT RELOCATION PERFORMANCE REQUIREMENT

2.1 PERFORMANCE REQUIREMENTS

- A. The relocation of the existing VRF system would require contractor to provide actual piping take off (pipe size and length), to MJEC VRG Group (existing VRF system manufacturer representative), to calculate new line sizes and refrigerant charge. New extension of refrigerant piping shall not be charged without MJEC's and engineer's approval.
 1. Provide system refrigerant calculations.

- a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
 - b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.
 2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
 3. System Refrigerant Piping and Tubing:
 - a. Arrangement: Arrange piping to interconnect indoor units[, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
 - b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
 - c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.
 4. System Controls:
 - a. Product selection.
 - b. Sizing.
- B. Service Access:
1. Provide and document service access requirements.
 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
 5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
 6. Comply with OSHA regulations.
- C. System Design and Installation Requirements:
1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
 2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
- D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.

1. Each branch circuit shall accommodate addition of two indoor unit(s) with unit capacity equal to largest indoor unit connected to the branch circuit.
 2. Each branch circuit shall accommodate deletion of two indoor unit(s) with unit capacity equal to largest indoor unit connected to the branch circuit.
- E. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
- F. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
1. Not less than 60 percent.
 2. Not more than 150 percent.
 3. Range acceptable to manufacturer.
- G. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
- H. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- I. Capacities and Characteristics: As indicated on Drawings.

2.2 SYSTEM CONTROLS

- A. General Requirements:
1. All control work associated with relocation of existing indoor units shall match the existing control including existing temperature control and sequence of operation.

2.3 SYSTEM REFRIGERANT AND OIL

- A. Refrigerant:
1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
 2. ASHRAE 34, Class A1 refrigerant classification.
 3. R-410a.
- B. Oil:
1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.4 SYSTEM CONDENSATE DRAIN PIPING

- A. New extension of drain pipe material to match existing.

2.5 SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Refrigerant Tubing Kits:

1. Match with existing and recommendations by existing VRF HVAC system manufacturer.

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.6 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel.

B. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded, zinc-coated steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: [Zinc-coated] [or] [stainless] steel.

2. Outdoor Applications: Stainless steel.

2.8 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 3. Hardware: Galvanized steel or polycarbonate.
 4. Accessories: Protection pads.
- C. High-Profile, Multiple-Pipe Stand:
 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: Two or more; vulcanized rubber
 3. Vertical Members: Two or more, stainless steel channels.
 4. Horizontal Members: One or more, adjustable height, stainless steel pipe support.
 5. Pipe Supports: Roller Strut clamps Clevis hanger Swivel hanger.
 6. Hardware: Stainless steel.
 7. Accessories: Protection pads[, 1/2-inch continuous-thread rod.
 8. Height: 36 inches above roof <Insert lesser dimension above roof.
- D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 MISCELLANEOUS SUPPORT MATERIALS

- A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.10 PIPING AND TUBING INSULATION

- A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

- a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
- b. Indoors: 1 inch thick.
- c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:

- a. Concealed: None required.
- b. Indoors, Exposed to View: PVC, 20 mils thick Insert jacket.
- c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch thick.

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

- a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
- b. Indoors: 1 inch thick.
- c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:

- a. Concealed: None required.
- b. Indoors, Exposed to View: PVC, 20 mils thick.
- c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch thick.

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

F. Metal Jacket Flashing Sealants:

- 1. Materials shall be compatible with insulation materials, jackets, and substrates.
- 2. Fire- and water-resistant, flexible, elastomeric sealant.
- 3. Service Temperature Range: Minus 40 to plus 250 deg F
- 4. Color: Aluminum.

2.11 SYSTEM CONTROL CABLE AND RACEWAYS

A. Low-Voltage Control Cabling:

- 1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

B. TIA-485A Network Cabling:

- 1. Standard Cable: NFPA 70, Type CMG.
- 2. Plenum-Rated Cable: NFPA 70, Type CMP.

- C. Ethernet Network Cabling: TIA-568-C.2 Category 6a cable with RJ-45 connectors.

2.12 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

- a. ASTM B117 for salt spray.
- b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
- c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: [Immersion] [Spray].

3. Thickness: 1 mil .

4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.13 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
 2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.
- C. Indoor Unit Installations:
1. Install units to be level and plumb while providing a neat and finished appearance.
 2. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).
 3. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
 4. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
 5. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
 6. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
 7. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.
 8. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
 9. Attachment: Install hardware for proper attachment to supported equipment.
 10. Grouting: Place grout under equipment supports and make bearing surface smooth.
- D. Outdoor Unit Installations:
1. Install units to be level and plumb while providing a neat and finished appearance.

3.2 GENERAL REQUIREMENTS FOR PIPING AND TUBING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping and tubing to permit valve servicing.
- F. Install piping and tubing at indicated slopes.

- G. Install piping and tubing free of sags.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping and tubing to allow application of insulation.
- J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
- K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors.
- L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors.

3.3 CONDENSATE DRAIN PIPE AND TUBING INSTALLATION

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
 - a. Details indicated on Drawings.
 - b. Manufacturer's requirements.
 - c. Governing codes.
 - d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.4 HYDRONIC PIPING AND TUBING INSTALLATION

- A. Install continuous-thread hanger rods and spring hangers of size required to support equipment weight.
- B. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.

3.5 REFRIGERANT PIPING AND TUBING INSTALLATION

- A. Refrigerant Tubing Kits:
 - 1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
 - 2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, 1/4 inch.
 - 3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.
- B. Install refrigerant piping according to ASHRAE 15 and governing codes.
- C. Select system components with pressure rating equal to or greater than system operating pressure.
- D. Install piping as short and direct as possible, with a minimum number of joints and fittings.
- E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- F. Install refrigerant piping and tubing in protective conduit where installed belowground.
- G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.
- H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:
 - 1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- I. When brazing, remove or protect components that could be damaged by heat.
- J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.
- K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
 - a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
 - b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.6 PIPE AND TUBING INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.
- B. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.7 FIRESTOPPING

- A. Comply with requirements in Div 07 section "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of manufacturer's service representative:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Refrigerant Tubing Positive Pressure Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
 2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psi, using dry nitrogen.
 3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
 4. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
 5. Submit test reports for Project record.
- C. Refrigerant Tubing Evacuation Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
 2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
 3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
 4. Prepare test report to record the following information for each test:

- a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
 - 5. Submit test reports for Project record.
 - 6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.
- D. System Refrigerant Charge:
- 1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
 - 2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
 - 3. System refrigerant charging shall be witnessed by system manufacturer's representative.
 - 4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.
- E. Products will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.9 STARTUP SERVICE

- A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
 - 1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
 - 2. Complete startup service of each separate system.
 - 3. Complete system startup service according to manufacturer's written instructions.
- B. Startup checks shall include, but not be limited to, the following:
 - 1. Check control communications of equipment and each operating component in system(s).
 - 2. Check each indoor unit's response to demand for cooling and heating.
 - 3. Check each indoor unit's response to changes in airflow settings.
 - 4. Check each indoor unit[, and outdoor unit for proper condensate removal.

- C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
 - 1. Installer shall correct deficiencies found during startup service for reverification.
- D. System Operation Report:
 - 1. After completion of startup service, manufacturer shall issue a report for each separate system.
 - 2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
 - 3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
 - a. All available system operating parameters shall be included in the information submitted.
- E. Witness:
 - 1. Provide written notice not less than 20 business days before start of startup service.

3.10 ADJUSTING

- A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

3.11 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

END OF SECTION 238129

SECTION 23 85 10

DIFFUSERS, GRILLES AND REGISTERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the requirements necessary to furnish all equipment, materials, and labor required to provide and install, with a finished or exposed appearance compatible with other building finishes, the following: diffusers, grilles, and registers.

1.2 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with the latest version of ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.

1.3 SUBMITTALS

- A. Provide the following within 3 weeks of award of Contract: shop drawings including complete specifications, catalog cuts, and descriptive literature. Include at a minimum, the following information:
 - 1. Make, model, and dimensions.
 - 2. NC sound data.
 - 3. Velocity data.
 - 4. Static pressure drop data.
 - 5. Throw at applicable pattern deflection.
 - 6. Finishes.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Air Motion Performance: Select devices based on air being introduced into the room at 20 degrees F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 fpm, with a temperature uniformity of not greater than 1.5 degrees F.
- B. Acoustical Performance: Select devices that do not exceed the criteria as shown on the schedule in the drawings.
 - 1. The location and type are followed by a hyphen and a number to make each callout unique.

- C. Pattern Designation: The pattern designation indicates the core style for diffusers with optional cores that determine pattern of throw. The directions of throw may not be indicated for diffusers with field-adjustable pattern control.
 - 1. Throw arrows indicate the directions of throw if other than four-way.
 - 2. Provide diffusers with the pattern and directions of throw indicated. When the pattern designation is left blank and direction-of-throw arrows are absent the pattern shall be four-way, except for slot and linear diffusers, which shall be two-way, with equal volume in each direction.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect all equipment for damage upon delivery, and immediately report damage to the Owner. Repair damaged equipment to like-new condition or replace if damaged beyond repair.

3.2 FIELD PREPARATION

- A. Store equipment under cover in a secure area off the ground in a manner allowing easy inspection and inventory.

3.3 INSTALLATION

- A. General Considerations:
 - 1. Install items in accordance with manufacturer's instructions.
 - 2. Install diffusers, grilles, and registers tight on their respective mounting surfaces. Install plumb and true with room dimensions, accurately centered on projections, recesses, windows, ceiling grids, light fixtures, or doors. Provide appropriate frames wherever necessary to adapt to mounting surface.
 - 3. Make airtight connections to ductwork.
 - 4. Install extractors on all duct-mounted diffusers, behind all duct-mounted supply grilles, and where shown. Turning vanes are acceptable if the condition is the last outlet on a branch.
- B. Special Considerations for Ceiling Diffusers: Where flexible ductwork is used to make connections to ceiling diffusers, install a minimum of three duct diameters of straight ductwork without bends immediately upstream of the diffuser to provide uniform air distribution at the inlet collar. If this cannot be achieved, install an insulated sheet metal, 90-degree inlet box with turning vanes on the diffuser inlet. Turning vanes are not required if modular core diffusers are supplied.

3.4 ADJUSTING AND CLEANING

- A. Remove debris, vacuum dust from installed materials. Remove by manufacturer's recommended method.

- B. Set pattern control for directions of throw as shown on Drawings and set volume dampers to wide-open position prior to the air balance Contractor arriving on project.

END OF SECTION

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SECTION 26 05 01

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements specifically applicable to Division 26.
- B. Work Specifically Excluded from Project:
 - 1. Power company metering current transformers, meter and interconnecting wiring.
 - 2. Power company service transformer.
 - 3. Power company medium voltage conductors to primary side of service transformer.
- C. Work installed but furnished under other Sections:
 - 1. Power company meter housing and current transformer cabinet.
 - 2. Primary conduits from power company pole to service transformer.
- D. Contractor's Responsibilities:
 - 1. Complete systems in accordance with the intent of these contract documents.
 - 2. Coordinate details of facility equipment and construction for specification divisions that affect work covered under this Division.
 - 3. Furnish and install incidental items not actually shown or specified, but that are required by good practice to provide complete functional systems.
- E. Intent of Drawings:
 - 1. Electrical plan drawings show general locations of equipment, devices, raceways, and floor boxes unless specifically dimensioned.
 - 2. Contractor: Responsible for proper routing of raceways subject to prior review by Owner.
 - 3. Perform the following in addition to what is indicated on the drawings and specifications.
 - a. Perform fault coordination study, voltage drop study, and protective device coordination study for the new Laboratory and Maintenance Building only, as indicated in Section 26 05 75 Fault Calculation and Protective Device Coordination Study.
 - b. Size pull and junction boxes not shown or sized on the drawings.
 - c. Route raceways, coordinating with other Contractors. Determine raceway highways in addition to those indicated on plans, including those for floor mounted devices. Coordinate in floor raceways with Technology Drawings to provide a coordinated raceway installation.
 - d. Increase raceway sizes as needed based upon actual wire size.
 - e. Develop installation details based upon the drawings and specifications.

- f. Route and size grounding system based upon drawings and specifications. Include bonding jumpers and grounding electrode conductors to separately derived sources and service entrances.
- g. Develop wiring and control diagrams based upon Supplier drawings to supplement those shown on the drawings.
- h. Develop electrical equipment front elevations and footprint dimensions for layout, purchase, and installation.
- i. Based upon lighting fixture and switch layout drawings, design and connect system to include power, neutral, ground, and switch-leg conductors. Provide conductors for low voltage control of fixtures with dimmer switches.
- j. Do not route redundant circuits in the same raceway system.
- k. Lay out electrical distribution equipment per National Electrical Code (NEC) required clearances.
- l. Design, furnish, and install for the new Laboratory and Maintenance Building only the following systems:
 - 1) Lightning protection system per Section 26 41 00 Facility Lightning Protection.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. InterNational Electrical Testing Association (NETA)
 - 3. National Electrical Code (NEC)
 - 4. National Electrical Contractors Association (NECA)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. National Fire Protection Association (NFPA)
 - 7. Occupational Safety and Health Administration (OSHA)
 - 8. Underwriters Laboratories Inc. (UL)

1.3 DESIGN CRITERIA

- A. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within an ambient temperature of 30 to 104 degrees F, relative humidity of zero to 95 percent.
- B. Compliance by Contractor with provisions of this Section does not relieve the Contractor of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at specified service conditions.
- C. Electrical Components and Systems Manufactured within the Scope of Underwriters Laboratories Inc. (UL): Conform to UL standards, provide UL listing, and label with an applied UL listing mark or listing mark from a Nationally Recognized Testing Agency.
- D. Equipment: Meet applicable requirements of Factory Mutual.
- E. Indoor Dry Areas: Use National Electrical Manufacturers Association (NEMA) 1 enclosures for electrical equipment and devices in these areas unless otherwise indicated.

- F. Outdoor and Wet Areas: Use NEMA 3R enclosures for electrical equipment and devices in these areas unless otherwise indicated.
- G. Corrosive Areas: Designated on the drawings. Provide raceways, elbows, fittings, couplings, junction boxes, and pull boxes of materials specified hereafter. Use NEMA 4X enclosures for electrical equipment and devices in these areas. Provide other devices and materials labeled as suitable for installation in corrosive environment.
- H. Hazardous Areas: Designated on the drawings. Provide devices, materials, and equipment for installation in hazardous areas that are specifically approved for installation in hazardous areas of class, division, and group indicated and are of construction that ensures safe performance under conditions of proper use and maintenance.
- I. Close unused holes in boxes, equipment, and raceway.
- J. Remove abandoned outlets, cables, and conductors.

1.4 REGULATORY REQUIREMENTS

- A. Conform to latest codes and other legal requirements.
- B. Obtain permits and arrange inspections required by codes applicable to this Division. Submit written evidence to Owner that required permits, inspections, and code requirements have been secured.

1.5 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.6 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 NEC, as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label or a label from a Nationally Recognized Testing Agency.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials and Equipment: Labeled and/or listed as acceptable to AHJ as suitable for use intended.
- B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Install work using procedures defined in National Electrical Contractors Association (NECA) Standard of Installation.
- B. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.

3.2 SERVICE CONTINUITY

- A. Maintain continuity of electric service to functioning portions of processes or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with Owner. Keep outages to a minimum number and minimum length of time.

3.3 TOUCH-UP PAINTING

- A. Repair damage to factory-applied paint finishes with touch-up paint.
- B. Use touch-up paint and methods of preparation and application recommended by manufacturer of components to be repaired.

3.4 STARTUP TESTING AND INSPECTION OF ELECTRICAL EQUIPMENT

- A. Voltage: At project completion,
 - 1. Check voltage at termination point of power supply system to project.
 - 2. Check true rms voltage magnitude and balance between phases for loaded and unloaded conditions.
 - 3. Adjust taps of transformers such that no-load voltage is approximately equal to or up to 3 percent above nominal.

3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 01-01	Inspection and permit certificates and certificates of final inspection and acceptance from authority having jurisdiction		With record documents
26 05 01-02	Test reports		Before date of Substantial Completion

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. 600V Wire.
 - 2. 600V Cable.
 - 3. Wiring connections and terminations.
 - 4. Modular wiring system.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. National Electrical Code (NEC)
 - 3. National Fire Protection Association (NFPA)
 - 4. Underwriters Laboratories Inc. (UL)
 - 5. Variable frequency drive (VFD)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 600V WIRE

- A. Thermoplastic-insulated wire.
- B. Rubber-insulated wire.
- C. Feeders and Branch Circuits Larger than 6 AWG: Copper, stranded conductor, 600-Volt insulation, THHN/THWN.
- D. Feeders and Branch Circuits 6 AWG and Smaller: Copper, solid conductor, 600V insulation, THHN/THWN.
- E. Feeders and Branch Circuits installed below-grade or in wet or damp locations: Copper, solid or stranded conductor, 600V insulation, XHHW-2.
- F. Control Circuits: Copper, stranded conductor, 600-Volt insulation, THWN.

2.2 REMOTE CONTROL AND SIGNAL CABLE

- A. Type 1, 600-Volt Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:
 - 1. Individual Conductors: 14 AWG, stranded copper, PVC insulation, nylon jacket, rated 90 degree C dry, 75 degree C wet; color coded per ICEA Method 1, plus one green equipment grounding conductor.
 - 2. Assembly: Bundle wrapped with cable tape and covered with PVC jacket.
 - 3. Provide grounding conductor in addition to number of conductors to be used.
- B. Type 2, 300-Volt Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits:
 - 1. Individual Conductors: 14 AWG, solid copper, PVC insulated, rated 105 degree C dry, individual conductors twisted together plus bare stranded tinned copper drain conductor.
 - 2. Assembly: Bundle covered with overall PVC jacket.
- C. Type 3, 150-Volt Plenum-Rated Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits:
 - 1. Individual Conductors: 14 AWG, solid copper, Teflon insulated, rated 60 degree C, individual conductors twisted together.
 - 2. Assembly: Bundled covered with overall clear or red Teflon jacket.

2.3 COMMUNICATIONS SYSTEMS CABLE

- A. For communications systems cable also refer to Section 27 10 10 Basic Communications Materials and Methods.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits and no smaller than 14 AWG for control wiring.
- B. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
- C. Splice cables only with written permission of Owner. Show splice locations on as-constructed drawings.
- D. Conductors exposed to oils, greases, vapors, fumes, liquids, or other substances having deleterious effect on the conductor or installation shall be of a type suitable for the application.
- E. No conductor shall be used in such a manner that its operating temperature exceeds that designated for the type of insulated conductor involved.
- F. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- G. Make conductor lengths for parallel circuits equal.
- H. Where connection of cables installed under this Section is to be made by others, provide pigtails of adequate length for neat, trained, and bundled connections.

3.2 INSTALLATION

- A. Wiring in Raceways:
 - 1. No conductors or cables shall be installed in conduits, ducts, or raceways until the raceway has been completed.
 - 2. When installing conductors, the electrical contractor shall exercise due care to prevent damage to conductors or insulation.
 - 3. Pull conductors into a raceway at the same time. Use UL listed, approved and compatible wire pulling lubricant for pulling 4 AWG and larger wires.
 - 4. Install wire in raceway after interior of building has been physically protected from weather and mechanical work likely to injure conductors has been completed.
 - 5. Completely and thoroughly swab raceway system before installing conductors.
- B. Cable:
 - 1. Provide protection for exposed cables where subject to damage.
 - 2. Support cables above accessible ceilings; do not rest on ceiling tiles. Use UL listed spring metal clips or nylon plastic cable ties to support cables from structure. Include bridle rings or drive rings.
 - 3. Use suitable UL listed cable fittings and connectors.
 - 4. Install life safety and security systems cable per the requirements of NFPA 72, National Fire Alarm Code.

3.3 WIRING CONNECTIONS AND TERMINATIONS

- A. All feeder cables shall be continuous from origin to panel or equipment terminations without running splices in intermediate pull or splice boxes. Where taps and splices are necessary and approved in writing by the Engineer, they shall be made in approved splice boxes with suitable connector. Splice boxes are to be accessible.
- B. Use solderless pressure connectors with insulating covers for copper wire splices and taps 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
- C. Terminate control circuit conductors at terminal blocks only.
- D. Use split bolt connectors for copper wire splices and taps 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of conductor insulation value.
- E. Thoroughly clean wires before installing lugs and connectors.
- F. Where approved, make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise.
- G. Spare conductors are to be coiled and taped and mark as "SPARE".
- H. Splice below-grade conductors in handholes or manholes and make watertight with UL approved epoxy resin-type splicing kits.
- I. Label conductors according to the requirements of Section 26 05 53 Identification for Electrical Systems.

3.4 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Torque test conductor connections and terminations to manufacturer's recommended values.
- C. Perform continuity and insulation tests on power and equipment branch circuit conductors. Verify proper phasing connections.
- D. Life Safety and Security Systems Cable:
 - 1. Test cable per requirements of NFPA 72, Fire Alarm Code.
 - 2. Test spliced cable shields for continuity and isolation from ground.

3.5 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Concealed Interior Locations: Building wire in raceways.
- B. Exposed Interior Locations: Building wire in raceways.
- C. Above Accessible Ceilings: Building wire in raceways.

- D. Wet or Damp Interior Locations: Building wire in raceway.
- E. Exterior Locations: Building wire in raceways.
- F. Underground Locations: Building wire in raceways.

3.6 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 19-01	Catalog cutsheets, other descriptive literature		Prior to delivery
26 05 19-02	Field test results		Before date of Substantial Completion

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary for the new Laboratory and Maintenance Building and as applicable to the Mini Laboratory and Admin Renovation to furnish and install:
 - 1. Power system grounding.
 - 2. Communication system grounding.
 - 3. Electrical equipment, raceway, and cable tray grounding and bonding.
 - 4. Metal piping system bonding.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. Distributed Control System (DCS)
 - 3. Ground fault circuit interrupter (GFCI)
 - 4. Institute of Electrical and Electronic Engineers, Inc. (IEEE)
 - 5. National Electrical Code (NEC)
 - 6. National Fire Protection Association (NFPA)
 - 7. Programmable Logic Controller (PLC)
 - 8. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

1.5 SYSTEM DESCRIPTION

- A. Ground and bond electrical systems and equipment including separately derived sources and communications systems per requirements of National Electrical Code (NEC) Article 250.
- B. Provide communications system grounding conductor at fiber utility point-of-service entrance and connect to facility ground ring.
- C. Provide separate isolated equipment grounding conductor bonded to system at service or separately derived source. Avoid multiple connections to allow reduction of electrical noise.

PART 2 - PRODUCTS

2.1 GROUND RODS

- A. Copper clad steel, 3/4-inch diameter, 10 feet long, driven full length into the earth.

2.2 GROUND CONDUCTORS

- A. Provide grounding conductors sized as shown on drawings.
- B. Provide bare stranded copper conductors below grade. For above grade provide green insulated stranded copper. Support conductor as required using straight sections of PVC conduit.
- C. Above ground provide Green THHN/THWN with 600V insulation where routed in conduit.
- D. When ungrounded conductors increased in size, or run in parallel proportionately increase equipment grounding conductor per NEC Article 250

2.3 TEST WELLS

- A. Provide test wells as indicated on drawings.

2.4 GROUND CONNECTIONS

- A. Below Grade: Exothermic welded-type connectors by Cadweld, Thermoweld or compression type connectors designed for purpose unless indicated otherwise.
- B. Above Grade or in Manholes: Exothermic welded-type connectors by Cadweld, Thermoweld or compression type UL listed connectors designed for purpose.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not splice grounding conductors, except in junction or outlet boxes.
- B. Provide separate, insulated equipment grounding conductor in feeder and branch circuits.
- C. Provide grounding electrode conductors in 1-inch minimum PVC conduit from separately derived sources to nearest effectively grounded building steel.
- D. Provide ground conductor(s) to extend facility ground ring to location in each communications room as shown on drawings. Use same type and size conductor used for ground ring; thermite weld pigtail to ground ring.
- E. Provide grounding and bonding at utility company's metering equipment and pad-mounted transformer.
- F. Bare Grounding Conductors Below Grade:
 - 1. Ground Ring shall be buried at a depth of not less than 30 inches below the soil.
 - 2. Not in contact with gravel fill or concrete unless making transition from connections above slab to conductors below grade.
 - 3. Neatly trained around foundations, footings, and other obstacles.
- G. Ground Resistance: maximum 5 ohms unless otherwise accepted. Install sufficient ground rods in addition to code-required grounding if necessary. Where more than one rod required, install rods at least 8 feet apart.
- H. Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Provide electrical continuity between metal frames and railings supporting push-button stations, receptacles, instrument cabinets, etc., and raceways carrying circuits to these devices.
- I. Bond metal piping systems and metal air ducts that may become energized to nearest effectively grounded building structural steel member.
- J. Grounding Connections:
 - 1. Connect grounding conductors to ground rods at upper end of rod with end of rod and connection point below finished grade.
 - 2. Connect sections of outdoor ground mats (counterpoise) for substations or other equipment below grade. Connect other grounding conductors generally in an accessible manner.
 - 3. At telephone manholes, install ground rod outside vault in duct bank trench. Connect ground rod to bonding ribbons inside manhole with a minimum, 6-AWG copper conductor.
 - 4. Use exothermic welding cartridges and molds in accordance with manufacturer's recommendations. For compression connectors, refer to manufacturer's installation recommendations. Notify Owner prior to backfilling ground connections.

5. When making bolted connection to aluminum or galvanized structures, apply corrosion inhibitor such as Ideal NOALOX, or Penetrox A to contact surfaces between cable, connector, and surface of structure.

3.2 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
 1. Fall-of-Potential Test:
 - a. Connect instrument per manufacturer's instructions.
 - b. Locate C2 probe five times longest distance across grid being tested away from grid.
 - c. Place rod P2 at various locations in line between tested electrode and probe C2 and plot results on graph (distance versus resistance). Take sufficient readings to yield portion of plotted curve as being constant (rate-of-resistance change becomes so small with respect to distance as to be insignificant).
 2. Intercepting Slope Test:
 - a. Provide in lieu of fall-of-potential test for large grids.
 - b. Perform in accordance with Biddle Instruments guidelines.
 3. Conduct two separate tests on opposite sides of grounding grid.
 4. Report failure to obtain specified ground resistance to Owner.
- B. Test ground fault circuit interrupter (GFCI) receptacles, alarm systems, and circuit breakers for proper connection and operation with methods and instruments prescribed by manufacturer.
- C. Include reports of grounding system tests in operation and maintenance manuals for review by Owner.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 26-01	Field test results		Before date of Substantial Completion
26 05 26-04	Operation and maintenance manuals (reports of grounding system tests)		Before date of Substantial Completion

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Conduit, wireway, cable tray, and equipment supports, including design.
 - 2. Fastening hardware.
 - 3. Concrete equipment pads.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. Fiberglass-reinforced plastic (FRP)
 - 3. National Electrical Code (NEC)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide support systems adequate for weight of equipment, conduit, wireways, and/or cable trays, including wiring that they carry.
- B. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- C. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- D. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- E. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

1.5 COORDINATION

- A. Coordinate size, shape, and location of concrete pads with Section 03 30 00 Cast-in-Place Concrete.
- B. Generator concrete pad is detailed in Structural drawings.
- C. Power Company service transformer shall be provided in accordance with the current design requirements located on the Power Company website.

1.6 DESIGN CRITERIA

- A. Support systems in compliance with project seismic requirements.
- B. Design per project criteria.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel, Slotted Channel Framing, or Angle:
 - 1. Indoor Areas: Painted steel.
 - 2. Outdoor Areas: Galvanized steel
- B. Hardware:
 - 1. Outdoor Areas: Corrosion resistant.
 - 2. Indoor Areas: Cadmium- or zinc-plated steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using beam clamps. Do not use spring steel clips and clamps.
- B. Use expansion anchors or preset inserts in solid masonry walls, self-drilling anchors or expansion anchors on concrete surfaces, and sheet metal screws in sheet metal studs.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, cable, conduit, or vegetation.
- D. Do not use powder-actuated anchors without written permission from Owner.
- E. Do not drill structural steel members without written permission from Owner.
- F. Fabricate supports from slotted channel framing, structural steel, angle, or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring-lock washers under nuts.
- G. Install channel with open face down to avoid collection of debris.

- H. Install surface mounted cabinets and panelboards as required but with no less than four anchors. Provide steel channel supports to stand cabinets 1 inch off wall.
- I. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.
- J. Provide extra care in supporting PVC conduit to protect it from potential damage.
- K. Use fiberglass or special-coated metallic supports in areas subject to corrosives.
- L. Support individual raceways using clamps, wall brackets, strap hangers, or ceiling trapeze. Support multiple raceways/cable trays running adjacent to each other by ceiling trapeze.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 29-01	Product data indicating accessory construction, testing limitations, materials, and ratings.		Prior to delivery

END OF SECTION

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Rigid metal conduit (RMC) and fittings.
 - 2. Electrical metallic tubing (EMT) and fittings.
 - 3. Flexible metal conduit (FMC) and fittings.
 - 4. Liquidtight flexible metal conduit (LFMC) and fittings.
 - 5. Rigid polyvinyl chloride conduit (PVC) and fittings.
 - 6. Electrical nonmetallic tubing (ENT) and fittings.
 - 7. Conduit supports, clamps, and straps.
 - 8. Warning tape.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. Electrical metallic tubing (EMT)
 - 3. Electrical nonmetallic tubing (ENT)
 - 4. Flexible metal conduit (FMC)
 - 5. Liquidtight flexible metal conduit (LFMC)
 - 6. National Electric Code (NEC)
 - 7. National Electrical Manufacturers Association (NEMA)
 - 8. National Fire Protection Association (NFPA)
 - 9. Polyvinyl chloride conduit (PVC)
 - 10. Rigid galvanized steel (RGS)
 - 11. Rigid metal conduit (RMC)
 - 12. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally
- B. Recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- C. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.

- D. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- E. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 RMC AND FITTINGS

- A. RMC: Rigid Galvanized Steel (RGS).
- B. PVC Externally Coated Conduit: Rigid steel conduit with external 40-mil PVC coating and internal phenolic coating over a galvanized surface.
- C. Fittings and Conduit Bodies: Threaded type, aluminum. Do not use setscrew-type couplings, elbows, sweeps, or nipples. Provide bushings with shoulders, grounding lugs, and insulated nonmetallic throats.
- D. Hazardous Area Sealing Fittings: Threaded-type conduit seal fittings and sealing compound UL listed for hazardous locations in accordance with the US National Electric Code (NEC) Article 500.

2.2 EMT AND FITTINGS

- A. EMT: Galvanized tubing.
- B. Fittings and Conduit Bodies: National Electrical Manufacturers Association (NEMA) FB 1; steel, compression type. Provide bushings with insulated nonmetallic throats and shoulders. Provide grounding lugs for bushings on feeders.

2.3 FMC AND FITTINGS

- A. Conduit: Steel
- B. Fittings and Conduit Bodies: Steel.

2.4 LFMC CONDUIT AND FITTINGS

- A. Conduit: Flexible metal conduit with PVC jacket.
- B. Fittings and Conduit Bodies: Metal with PVC jacket.
- C. Ground continuity between end connectors via internal or external bonding jumper or braided strap.

2.5 RIGID PVC AND FITTINGS

- A. Conduit: Schedule 40 PVC.
- B. Fittings and Conduit Bodies: PVC.

2.6 CONDUIT SUPPORTS, CLAMPS, AND STRAPS

- A. Metallic Raceway Systems: Galvanized steel or cadmium plated steel
- B. Nonmetallic Raceway Systems: Nonmetallic fiberglass-reinforced plastic or nylon, polypropylene, or PVC.

2.7 WARNING TAPE

- A. Electrical Warning Tape:
 - 1. Heavy-gauge plastic tape for use in trenches containing electric circuits.
 - 2. Made of material resistant to corrosive soil.
 - 3. 6-inch minimum width red tape with printed warning that an electric circuit is located below tape.
- B. Communications and Life Safety/Security Warning Tape:
 - 1. Metallic tape with tin or nickel coated joining clips furnished by tape manufacturer.
 - 2. Communications Circuits: 6-inch minimum width orange tape with printed warning that communication circuit is located below tape.
 - 3. Life Safety/Security Circuits: 6-inch minimum width yellow tape with printed warning that life safety circuit is located below tape.

PART 3 - EXECUTION

3.1 PROTECTION DURING CONSTRUCTION

- A. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction.

3.2 MINIMUM SIZES

- A. 3/4-inch minimum for exposed or concealed.

3.3 TYPE TO BE USED

- A. Exterior, Exposed:
 - 1. Galvanized steel RMC.
- B. Interior, Exposed:
 - 1. EMT.
- C. Interior, Wet Locations:
 - 1. Galvanized steel RMC.
- D. Interior, Concealed, Not Installed in Concrete:
 - 1. EMT.
- E. Above Ground, Embedded in Concrete:

1. Galvanized steel RMC.
- F. Underground, Direct Earth Burial:
 1. PVC.
 2. PVC-coated steel RMC vertical elbows.
- G. Underground, Concrete-Encased:
 1. PVC.
- H. Corrosive Nonhazardous Areas (Interior and Exterior, Exposed or Concealed): PVC.
- I. Hazardous Areas (Interior and Exterior, Exposed or Concealed): UL-approved galvanized steel RMC.
- J. Provide minimum 24 inches of cover over underground conduits in areas where traffic can drive over them. Use concrete reinforced encasement when using PVC for road crossings.
- K. Under slab Below 5 kV:
 1. Greater than or Equal to 3-Inch Diameter: PVC, 18-inch minimum depth below finished floor. Provide PVC-coated steel RMC bends for electrical conduits.
 2. Less than 3-Inch Diameter: PVC, 18-inch minimum depth below finished floor. Provide PVC-coated steel RMC bends for electrical conduits.
- L. In addition to the requirements in Section 26 05 49 Vibration Isolation for Electrical Systems, for final connection to valves, local instrumentation, and other equipment where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, use the following guidelines:
 1. 60-inch maximum lengths of LFMC with minimum 90-degree turn resulting in a loose and compliant connection.
 2. Provide flexible conduit long enough to allow item to which it is connected to be withdrawn or moved off its base.
 3. Plenums or Ducts: Maximum 48-inch lengths of LFMC.
 4. Do not use FMC except for:
 - a. Final connection to non-vapor-tight or nonweather-resistant light fixtures. Do not exceed 72 inches length and provide minimum diameter of 3/8 inch.
 - b. Non-plenum spaces used for environmental air.

3.4 SPECIAL LOCATIONS

- A. Use PVC-coated RMC for electrical installations:
 1. Where conduit changes from underground, direct burial to exposed.
 2. Under equipment mounting pads.
 3. To points at least 5 feet outside building walls and concrete slabs.

3.5 LOCATION, ROUTING, AND GROUPING

- A. Arrange conduit to maintain headroom and present neat appearance.

- B. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- C. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources. Maintain minimum 18-inch clearance above ceiling grid.
- D. Arrange conduit supports to prevent distortion of alignment by wire-pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
- E. Group conduit in parallel runs where practical and use conduit rack per the requirements of Section 26 05 29 Hangers and supports for electrical systems. Provide space for
- F. 25 percent additional conduit for each size of conduit in rack. If 25 percent equals a fraction of a conduit, round up to next even number.
- G. Attach conduit support systems to structure, not to piping or ductwork.
- H. Provide supports minimum 8 feet on center for conduits smaller than 2 inches.
- I. Do not fasten conduit with wire or perforated pipe straps. Remove wire used for temporary conduit support during construction, before conductors are pulled.
- J. Do not notch structural members for passage of raceways.
- K. Combine homeruns for lighting and general-purpose receptacle circuits if desired but assume responsibility for conduit size and conductor de-rating. Do not combine neutral conductors or other circuits.

3.6 BENDS

- A. General: Use hydraulic one-shot conduit bender or factory elbows and sweeps for bends in conduit larger than 2-inch size. Provide concentric parallel bends.
- B. Electrical Conduit Bends:
 - 1. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90-degree bends are required, obtain prior approval from Owner.
 - 2. Use conduit bodies to make sharp changes in direction, as around beams. Install conduit bodies in readily accessible locations.
- C. Communications and Life Safety/Security Conduit Sweeps:
 - 1. Make changes in direction of communications conduit runs with symmetrical sweeps of the longest possible radius. Provide minimum inside radius for 4-inch underground and under slab communications conduit sweeps of 60 inches, and ten times conduit internal diameter for other runs.
 - 2. Install no more than the equivalent of two 90-degree bends between pull points and/or pull boxes.
 - 3. Make no bends in flexible conduit that exceed allowable cable bending radius or that significantly restrict conduit flexibility.

3.7 CONDUIT INSTALLATION

- A. Cut conduit square using saw or pipe cutter. Deburr cut ends.
- B. Bring conduit to shoulder of fittings and couplings and fasten securely.
- C. Damp or Wet Locations: Use conduit hubs for fastening conduit to boxes and equipment. Enter bottom of electrical equipment with conduit.
- D. Install insulating throat connectors wherever raceway terminates in boxes or cabinets.
- E. Cap exposed steel communications conduit ends with bushings or smooth collars to protect cable sheath.
- F. Avoid moisture traps. Where unavoidable, provide junction box with drain/breather configuration.
- G. Pull Ropes and Pull Tapes:
 - 1. Provide pull ropes or pull tapes secured at each end of each empty conduit, except sleeves and nipples.
 - 2. Use nylon pull tape with printed footage indicators for each empty electrical conduit.
 - 3. Identify with tags at each end the origin and destination of each empty conduit and indicate same on empty or spare conduit on as-built drawings.
- H. Where conduit penetrates fire-rated walls and floors, seal opening around conduit with UL-listed foamed silicone elastomer compound with rating equal to or greater than wall/floor penetrated.
- I. Provide watertight seal where underground conduit enters structure through wall or floor.
- J. Route conduit through roof openings for piping and ductwork where possible. Otherwise, route through roof jack with pitch pocket. Coordinate roof penetrations.
- K. Maximum Size Conduit in Slabs Above Grade: Route conduit below slab on grade. Do not route conduit in concrete slab.
- L. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes, minimum.
- M. Install concealed, embedded, and buried conduit to emerge at right angles to surface and have no curved portion of bend exposed.

3.8 UNDERGROUND DUCTBANK INSTALLATION

- A. See Section 31 23 23.13 – Excavation and Backfill for Utilities, for trenching and backfill requirements.
- B. Install top of duct bank maximum 30 inches below finished grade.

- C. Install conduit with minimum grade of 4 inches per 100 feet, either from one handhole, manhole, or pull box to next, or from high point between them, depending on surface contour.
- D. Install conduits entering handholes, manholes, and structures at right angles.
- E. Terminate conduit in end bell at electrical manhole entries and in watertight 4-inch duct terminators at communications manhole entries.
- F. Stagger conduit joints in concrete encasement 6 inches minimum vertically.
- G. Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at maximum 4-foot intervals. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement.
- H. Do not use union-type fittings.
- I. Bury warning tapes 12 inches above duct bank.
- J. Do not backfill underground duct banks until Owner has observed them.
- K. Pull 3-1/2-inch-diameter by 12-inch mandrel through 4-inch communications ducts to verify circularity and sweep radius. Pull standard length mandrels through other underground conduits. Request Owner to observe these activities.
- L. Provide expansion fittings at structural isolation breaks. Use a ground jumper or bonding strap across expansion fitting attached to conduit ends for ground continuity.

3.9 EMPTY RACEWAYS

- A. Electrical Conduit: Provide permanent cap over each end of each empty raceway.
- B. Provide pull rope or pull tape in each empty electrical and communications conduit as specified above. Tie pull tape securely to duct plug or wall racking at each end.
- C. Provide conduit identification at each end.

3.10 IDENTIFICATION

- A. Follow requirements of Section 26 05 53 Identification for Electrical Systems.

3.11 GROUNDING

- A. Follow requirements of Section 26 05 26 Grounding and Bonding for Electrical Systems.

3.12 VIBRATION ISOLATION

- A. Follow requirements of Section 26 05 49 Vibration Isolation for Electrical Systems.

3.13 HANGERS AND SUPPORTS

- A. Follow requirements of Section 26 05 29 Hangers and Supports for Electrical Systems.

3.14 BOXES AND FITTINGS

- A. Coordinate conduits with Section 26 05 05 Basic Electrical Materials and Methods.
- B. Close unused openings in raceways, boxes, and fittings.

END OF SECTION

SECTION 26 05 34

SURFACE RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Multioutlet assemblies.
 - 2. Auxiliary gutters (wireways).
 - 3. Communications wireway systems.
 - 4. Communications plastic wiring duct.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority Having Jurisdiction (AHJ)
 - 2. American Wire Gauge (AWG)
 - 3. US National Electric Code (NEC)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. National Fire Protection Association (NFPA)
 - 6. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (US National Electric Code), as applicable. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 MULTIOUTLET ASSEMBLY

- A. Acceptable Manufacturers:
 - 1. Wiremold ALA4800.
- B. Approved equal. Multioutlet Assembly: Sheet metal channel with fitted cover, suitable for use as a multioutlet assembly.
- C. Size: As indicated on Drawings.
- D. Receptacles: Outlets with receptacles as shown on Drawings. See Section 26 27 26 Wiring Devices, for receptacle requirements.
- E. Finish: Anodized aluminum finish.
- F. Fittings: Couplings, elbows, outlet and device boxes, and connectors designed for use with multioutlet system.

2.2 COMMUNICATIONS PLASTIC WIRING DUCT

- A. Acceptable Manufacturers:
 - 1. ADC.
 - 2. Telect.
 - 3. Panduit.
- B. Polyvinylchloride duct with slots on the sides to provide wire openings and removable snap-on cover.
- C. Size: As shown on the Drawings.
- D. Finish: Manufacturers' standard color.
- E. Fittings: Mounting devices, fasteners, wire retainers, joining and corner strips, and fiber optic duct fittings designed for use with the raceway system with which it is to be used.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Surface Multioutlet Assembly:
 - 1. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
 - 2. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
 - 3. Maintain grounding continuity between raceway components to provide a continuous grounding path.
 - 4. Fastener Option: Use clips and straps suitable for the purpose.

B. Communications Plastic Wiring Duct:

1. Use flat-head screws, nylon rivets, clips, stud fasteners, and other suitable methods recommended by the manufacturer to fasten plastic duct to surfaces. Mount plumb and level.
2. Use suitable joining strips to make straight-run duct channel connections.
3. Use suitable fittings at angled corner connections to protect wires and cables. For metallic cable, use corner strips. For fiber optic cable and jumpers, use suitable fiber optic duct fittings.

3.2 GROUNDING

- A. Follow the requirements of Section 26 05 26 Grounding and Bonding for Electrical Systems.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 34-01	Product data indicating accessory construction, testing limitations, materials, and ratings.		Prior to delivery

END OF SECTION

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SECTION 26 05 49

VIBRATION ISOLATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install vibration control devices, materials, and related items for electrical systems.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. Double Neoprene Pad (DNP)
 - 3. Hanger Neoprene or Glass Fiber (HN)
 - 4. National Electric Code (NEC)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. National Fire Protection Association (NFPA)
 - 7. Structural Isolation Breaks (SIB)
 - 8. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

- E. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- F. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- G. Supply and install incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- I. Should electrical equipment cause noise or vibration exceeding the manufacturer's specifications for the unit in question, perform remedial work required to reduce noise and vibration levels.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

- A. Unit Double Neoprene Pad (DNP):
 - 1. Acceptable Manufacturers:
 - a. Amber/Booth, Type NR.
 - b. Korfund Dynamics, Type Korpad.
 - c. Mason Industries, Type WSW.
 - d. Vibration Mountings & Control, Series Shear Flex.
 - 2. Form neoprene pad isolators with two layers of 1/4-inch- to 3/8-inch-thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate, permanently adhered together.
 - 3. Neoprene: 40 to 50 durometer.
 - 4. Size pads so that they will be loaded within the manufacturer's recommended range. Provide a steel top plate equal to the size of the pad to transfer the weight of the supported unit to the pads and to distribute the load evenly over the surface of the pads.
- B. Unit Hanger Neoprene or Glass Fiber (HN):
 - 1. Acceptable Manufacturers:
 - a. Amber/Booth, Type BRD-A.
 - b. Korfund Dynamics, Type H.
 - c. Mason Industries, Type HD.
 - d. Vibration Mountings and Control, Type RHD or RFD.
 - 2. Neoprene-in-shear or glass fiber element contained in a steel housing. Provide neoprene neck bushing or other element where hanger rod passes through hanger housing to prevent rod from contacting hanger housing. Diameter of hole in housing sufficient to permit the hanger rod to swing through a 30-degree arc before contacting the hanger housing.
- C. Isolation Pads – Unit Substations and Large Transformers:

1. Acceptable Manufacturers:
 - a. Kinetics Noise Control Inc., Model KIP.
 - b. Mason Industries, Model W.
2. Neoprene, neoprene and cork, or precompressed molded fiberglass noise and vibration isolation pads. Provide ribbed or waffle type neoprene pads. Individually coat fiberglass pads with a flexible moisture-impervious elastomeric membrane. Select pads for maximum deflection within their design load ranges for the equipment that they are to support. Provide 2-inch-thick pads with a natural frequency of 12 Hz or less, and 4-inch-thick pads with a natural frequency of 10 Hz or less. Provide pads with minimum thickness of 2 inches unless otherwise specified.
3. Do not short-circuit isolators by through bolting unless otherwise specified. Provide required restraint with snubbers.

2.2 FLEXIBLE ELECTRICAL CONNECTIONS

- A. Type A: Field fabricated using a minimum 24-inch length of flexible conduit or cable.
- B. Type B: Field fabricated using a minimum 48-inch length of flexible conduit or cable.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Transformers:
 1. Mount transformers within the building construction on unit DNP isolators. If the transformers are suspended, use Unit HN isolators selected to achieve not less than 0.1-inch static deflection.
 2. Make electrical connections to isolated transformers using flexible electrical connections. Use Type A connections for conduits less than 1 inch. Use Type B connections for conduits sized 1 inch and larger.
- B. Dimmers: Mount dimmer cabinets on Unit DNP isolators.
- C. Mechanical Equipment: Make electrical connections to vibration isolated mechanical equipment using flexible electrical connections. Use Type A or Type B connections for conduits less than 1 inch. Use Type B connections for conduits sized 1 inch and larger.
- D. Expansion Joints or Structural Isolation Breaks (SIB):
 1. Conduits Smaller Than 4-Inch: Install expansion-deflection joint where conduit crosses building expansion at column line 14 or SIB joints.
 2. Type A Connections: Use for conduits less than 1 inch.
 3. Type B Connections: Use for conduits sized 1 inch to 3-1/2 inch.
 4. Utilize pad isolators for busway, cable tray, wireway, and 4-inch and larger conduits at SIBs. Support one end on 1-inch deflection isolators for 25 feet on one side of SIB.

3.2 INSTALLATION

- A. General: Position isolated electrical equipment so that it is freestanding and does not contact the building structure or other systems.
- B. Isolation Mounts:
 - 1. Align mounts squarely above or below mounting points for the supported equipment.
 - 2. If a housekeeping pad is provided, install so that the isolators bear on the housekeeping pad and the isolator base plate rests entirely on the pad.
 - 3. Connect hanger rods for vibration isolated support to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
 - 4. Position vibration isolation hanger elements as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting objects.
- C. Flexible Electrical Connections:
 - 1. Install Type B connections in a grossly slack U shape or a 360-degree loop.
 - 2. Do not tie flexible coupling or conduit to the building structure or other rigid material beyond the point where it takes off from the rigid conduit.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 49-01	Provide a description of products to be supplied, including product data, dimensions, specifications, and installation instructions.		Prior to delivery

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Nameplates and tape labels.
 - 2. Wire and cable markers.
 - 3. Raceway color coding.
 - 4. Box identification.
 - 5. Signage and warning labels.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. National Electrical Code (NEC)
 - 3. National Fire Protection Association (NFPA)
 - 4. Power Distribution Unit (PDUs)
 - 5. Underwriters Laboratories Inc. (UL)
 - 6. Uninterruptible Power Supply (UPS)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 PART 2 PRODUCTS

2.1 MATERIALS

- A. Nameplates: Engraved three-layer laminated plastic, minimum 3/16-inch-high black letters on white background. Emergency Egress Lighting Equipment Nameplates: White letters on red background. Generator Distribution System Equipment Nameplates: White letters on orange background.
- B. Tape Labels: Embossed adhesive tape with minimum 3/16-inch Kroy black letters on white background.
- C. Wire and Cable Markers: Clear, heat-shrink tubing type from Brady LS2000 printer or equal; do not use cloth or wraparound adhesive types.
- D. Conductor and Raceway Color Tape: Colored vinyl electrical tape.

PART 3 PART 3 EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates or tape labels.
- B. Install nameplates and/or tape labels parallel to equipment lines.
- C. Secure nameplates to equipment fronts. Utilize noncorrosive screws for engraved nameplate mounting. Do not use adhesives. Secure nameplate to outside face of flush-mounted panelboard doors in finished locations.
- D. Use tape labels for identification of individual wall switches and receptacles, control device stations, and boxes.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each phase, neutral, and ground conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection.
 - 1. Power and Lighting Circuits: Identify with branch circuit or feeder number.
 - 2. Control Wiring: Identify with control wire number as indicated on equipment manufacturer's shop drawings.
 - 3. Life Safety and Security System Wiring: Identify according to requirements shown on life safety legend drawing.

- B. Identify conductors for power circuits per the following schedule.

Conductor	System Voltage	
	480Y/277V	208Y/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Neutral	Gray	White
Grounding	Green	Green
Switch leg (lighting)	Purple	Pink

3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates to identify electrical distribution and control equipment and loads served.
- Letter Height:

Equipment	Information	Letter Height
Panelboards, Switchboards, Uninterruptible Power Supplies (UPSs), Generators, Lighting Inverters	Equipment designation	1/4 inch
	Voltage rating and source	1/8 inch
Individual Circuit Breakers, Switches, Drives, Motor Starters, Switchboards,	Load served and source	1/8 inch
	Equipment designation	1/4 inch
	Primary and secondary voltages, primary source, and secondary load location	1/8 inch
Automatic Transfer Switches	Equipment designation, voltage rating, normal source, standby source, and load served, including location	1/4 inch 1/8 inch

3.4 LIFE SAFETY AND SECURITY SYSTEM DEVICE IDENTIFICATION

- A. Label devices with self-adhesive labels, 1/8-inch characters, black letters on white background per life safety drawings.
- B. Where view of device is obstructed by ceiling tile, place additional label on tile visible from floor.

3.5 RACEWAY COLOR-CODING SCHEDULE

- A. Use colored tape at 10-foot intervals to identify raceway by system.

System	Color
480-Volt, 3-Phase	Yellow
208-Volt, Single-Phase and 3-Phase	Black
Grounding	Green
General Control	Brown and White
Generator Power	Orange
UPS	Orange and Red
Emergency Egress Lighting from Inverter	Red
Fire Alarm System	Red and White

3.6 BOX IDENTIFICATION

- A. Use permanent black markers to identify circuits, destinations, and spares on junction and pull box lids. Clarify detail inside larger boxes. Lettering shall be clear and neat.

3.7 PANELBOARD COLOR CODE

- A. Post neutral and phase color codes at each panelboard.

3.8 SIGNAGE AND WARNING LABELS

- A. Place signs at service equipment noting location of generator and uninterruptible power supply systems.
- B. Provide warning ribbon on primary service laterals 12 inches minimum above underground installation.

3.9 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 53-01	Catalog cutsheets, other descriptive literature		Prior to delivery
26 05 53-02	Sample of labels for each system		Prior to delivery

END OF SECTION

SECTION 26 05 75

FAULT CALCULATION AND PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary for the new Laboratory and Maintenance Building only to perform the following:
 - 1. Fault calculations.
 - 2. Time-current coordination study
 - 3. Arc flash study.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. American National Standards Institute (ANSI).
 - 2. Institute of Electrical and Electronic Engineers, Inc. (IEEE).
 - 3. National Fire Protection Association (NFPA).

1.3 DESCRIPTION OF STUDY

- A. Provide fault (short-circuit) calculations for distribution system as indicated on drawings.
- B. As a minimum, utilize methods and guidelines outlined in American National Standards Institute (ANSI) C37 for equipment, ANSI C57 for transformers, Institute of Electrical and Electronic Engineers, Inc. (IEEE) 242 for protection and coordination, and IEEE 399 for analysis.
- C. Provide a protective device coordination study of sufficient portions of distribution system as indicated on drawings to ensure protective devices are coordinated. Base study on actual devices installed.
- D. An initial fault (short circuit) study and recommendations of equipment changes must be submitted and accepted prior to Owner approving affected equipment submittals.
- E. If a computer tool is used, the studies shall use a computer tool that is available beyond a certain electrical equipment manufacturer, such as SKM Power Tools. The model is to be given to the customer at the end of the project.

1.4 QUALIFICATIONS

- A. Prepare fault calculation and protective device coordination study furnished herein using the electrical equipment manufacturer who furnishes distribution equipment to contract site or an independent Electrical Engineer. In either case, Contractor to furnish study prepared by a professional Electrical Engineer licensed in State of Texas.
- B. Utilize persons experienced in the work for study preparation.

1.5 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Fault calculation and protective device study may be prepared with network analyzer, digital computer, or by written calculations, but must include complete fault calculations as specified herein for each proposed and ultimate source combination.
- B. Source combinations may include present and future power company supply circuits, large motors, alternate sources, tie breaker use, lighting inverters, uninterruptible power supplies, and generators.
- C. The drawings and specifications indicate general requirements for electrical equipment being provided. Changes and additions may be suggested by results of study. Submit proposed changes and additions as part of study.

2.2 FAULT (SHORT-CIRCUIT) CALCULATION

- A. Provide description of calculation methods, assumptions, and base quantities selected, as applicable.
- B. Provide one-line diagram(s), source impedance data including X/R ratio, bus data, transformer data, circuit resistance and reactance values, and power company system characteristics.
- C. Provide impedance diagrams or listings, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations.
- D. Provide calculation of short-circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each medium-voltage switchgear lineup, medium-voltage motor starter, unit substation primary and secondary terminals, low-voltage switchboard lineup, distribution panelboard, branch circuit panelboard, transformers, transfer switch, and other significant locations throughout system.
- E. Provide ground fault current calculations for same system areas as described herein, including associated zero sequence impedances.
- F. Provide tabulations including fault impedance, X/R ratios, asymmetry factors, motor contributions, short-circuit kVA, and symmetrical and asymmetrical fault current.
- G. Verify fault current levels are sufficient to operate protective devices.
- H. Verify equipment ratings exceed associated fault values.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Separate transformer primary protective device characteristic curves by 16 percent minimum current margin to provide proper coordination and protection in event of secondary line-to-line faults.
- B. Provide complete sets of individual protective device time-current coordination characteristics.
- C. List assumptions made and areas where ideal coordination not possible with equipment involved.
- D. When similar configurations exist in distribution system only one coordination curve required for each unique situation but provide summary of settings for every device.

2.4 ARC FLASH STUDY

- A. In the report, provide a listing of arc flash distances and energy levels per National Fire Protection Association (NFPA) 70 E.
- B. Provide arc flash labels and mount on the equipment.
- C. Revise if coordination settings are revised from section.

PART 3 - EXECUTION

3.1 ADJUSTING

- A. Submit fault calculation and coordination study in same bound report to Owner for review.
- B. After review by Owner, make revisions to protective device settings to accomplish conformance.
- C. Make adjustments to relays and devices.

3.2 DEMONSTRATION

- A. Demonstrate to Owner correct device settings and ratings are made.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED

26 05 75-01	Qualifications of person(s) performing study, including States of registration as a professional Electrical Engineer		Prior to delivery
26 05 75-02	Methods and software to be used including evidence of a valid software license. Name and version of software to be used.		Prior to delivery
26 05 75-03	Initial fault (short-circuit) calculations to allow equipment selection.		Prior to delivery
26 05 75-04	Initial deficiencies, less than ideal coordination, equipment not properly		Prior to delivery
26 05 75-05	Fault (short-circuit) calculations.		Prior to delivery
26 05 75-06	Protective device coordination study.		Prior to delivery
26 05 75-09	One-line diagram with each significant bus or node having a unique number		Prior to delivery
26 05 75-11	Final values and settings.		Prior to delivery
26 05 75-12	Electronic copy of data and library files from software used (list name, version,		With record documents
26 05 75-13	Correspondence with utility, including utility available fault current		With record documents
26 05 75-14	Arc flash labels.		Before date of Substantial Completion

END OF SECTION

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SECTION 26 08 10

ACCEPTANCE TESTING AND CALIBRATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section specifies testing low voltage power circuit breakers and molded case circuit breakers.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Direct current (DC).
 - 2. Hertz (Hz).
 - 3. National Electrical Testing Association (NETA).
 - 4. National Fire Protection Association (NFPA).
 - 5. Root mean squared (RMS).
- B. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- C. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.3 QUALITY ASSURANCE

- A. National Electrical Testing Association (NETA) membership is required for firm performing tests.

PART 2 - PRODUCTS

2.1 NOT APPLICABLE

PART 3 - EXECUTION

3.1 TESTING AND ACCEPTANCE

- A. General: National Fire Protection Association (NFPA) 70B. Institute and maintain following precautions during testing requiring applications of potentials above 30 volts:
 - 1. Erect barricades around testing areas and post warning signs.
 - 2. Station watchmen to ensure unauthorized persons do not approach energized conductors and components.
 - 3. Maintain telephone or voice radio contact between potential injection point and energized remote locations.

- B. Low-voltage Power Circuit Breakers:
1. Preparatory Work: Prior to testing, remove each breaker from its compartment and perform the following procedures.
 - a. Clean, lubricate, inspect, and adjust each breaker in accordance with manufacturer's published maintenance instructions.
 - b. Inspect contacts, arc quenchers, primary and secondary disconnects, current sensors, small wiring, and trip devices.
 - c. Examine contacts for condition, clearance, pressure, and wipe.
 - d. Adjust pressure for equal and minimum contact resistance on poles.
 2. Tests: Refer to manufacturer's test instructions. Determine and record the following data:
 - a. Breaker identification, including Project designation, manufacturer's ratings, serial number, trip device type, ranges, and time bands.
 - b. Test each breaker electrically for proper tripping characteristics by passing 60 Hertz (Hz). sinusoidal low voltage current through each pole, one at a time, with test current injection at primary disconnects.
 - 1) Perform tests at operating trip device settings as specified.
 - 2) Include this information in report plus record of settings "as left" after calibration and adjustment of trip devices for conformance with required pickup characteristics.
 - c. Apply sufficient current to actuate each mode of trip device (long time pickup, long time delay band, short time pickup, short time delay band, instantaneous pickup, ground pickup, and ground delay band as applicable). Record test current and elapsed time at tripping for each pole. State whether or not breaker tripping is within manufacturer's tolerances.
 - d. Perform insulation resistance test on each breaker. With contacts closed apply 1,000 volts direct current (DC) and take resistance readings after one-minute energization between each pair of poles and from each pole to breaker frame.
 3. Solid State Trips: Verify that adjustable trips are set as indicated in the results from the coordination study and required in Section 26 05 75- Fault Calculation and Protective Device Coordination Study . Test each pole of breaker for correct operation at each trip setting. Replace breakers or trip devices that fail to operate within breaker's published time-current current.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 08 10-01	Submit two bound copies of test reports certified by testing technician and approved representative authorized to witness tests.		With operations and maintenance manuals

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Intelligent Lighting controls.
 - 2. Occupancy Sensors.
 - 3. Timer Switches.
 - 4. Photocells/daylight sensors.
 - 5. Dimming control.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. American Wire Gauge (AWG)
 - 2. Authority having jurisdiction (AHJ)
 - 3. Electrical Testing Lab (ETL)
 - 4. Federal Communications Commission (FCC)
 - 5. Light emitting diodes (LEDs)
 - 6. National Electric Code (NEC)
 - 7. National Electrical Manufacturers Association (NEMA)
 - 8. National Fire Protection Association (NFPA)
 - 9. Time-of-day (TOD)
 - 10. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. General:
 - 1) Provide catalog data sheets and pictures for all products listed below.
 - b. Lighting Controls:
 - 1) Wiring diagram.
 - 2) Contact ratings.
 - 3) Functional features.
 - 4) Programmable capabilities.
 - 5) Enclosure type, dimensions.
 - c. Lighting Contactor:
 - 1) Type (mechanically or electrically held).
 - 2) Enclosure.
 - 3) Contact ratings and configuration.
 - 4) Coil operating voltage.

- d. Photoelectric Switches (Photocells):
 - 1) Voltage.
 - 2) Power consumption.
 - 3) Load capacity (watts).
 - 4) Contact ratings and configuration.
 - 5) Time delay.
 - 6) Light operating level controls.
 - 7) Enclosure type and dimensions.
 - 8) Mounting type.
 - 9) Temperature range.
 - 10) Features and options.
- e. Photo Sensors/Controls for Daylight Harvesting Control:
 - 1) System description, overall functionality.
 - 2) Each component.
 - 3) Electrical ratings (voltage, amperage, watts).
 - 4) Wiring diagrams.
 - 5) Programming.
 - 6) Testing.
- f. Wall box dimmers.
- g. Dimming systems.
- h. Occupancy Sensors:
 - 1) Type.
 - 2) Switching capacity.
 - 3) Coverage.
 - 4) Time delay AUTO/OFF adjustment.
- i. Emergency Shunt Relay.

- B. Informational Submittals:
 - 1. Manufacturer's printed installation instructions.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- D. Standard Products:
 - 1. Provide materials and equipment of manufacturers regularly engaged in the production of products specified in this section and that are of equal material, design, and workmanship.
 - 2. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to Bid opening in similar applications under similar circumstances

and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

- E. Pre-installation Meeting:
 - 1. Occupancy Sensors/Daylight Sensors: Arrange pre-installation meeting with manufacturer's factory authorized representative at Owner's facility, to verify placement of sensors and installation criteria.

PART 2 - PRODUCTS

2.1 INTELLIGENT LIGHTING CONTROL

- A. General:
 - 1. Lighting control components for lighting systems are to be suitable for the lighting system specified and compatible for interface with other associated control devices.
 - 2. Lighting control components are to be rated for continuous service and operate satisfactorily in every respect.
 - 3. Lighting control provider shall analyze reflected ceiling plan to design a detailed sensor layout that provides adequate occupancy and daylight sensor performance.
- B. Acceptable Manufacturers:
 - 1. Acuity Brands.
 - 2. Lutron.
 - 3. Legrand.
 - 4. Hubbell.
- C. Basic Features:
 - 1. Networkable, expandable controller-based system.
 - 2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming and/or scene control.
 - 3. The system shall be capable of providing individually addressable switching and dimming control of the following: networked luminaires, control zones to include multiple switch legs or circuits, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type. A single platform shall be used for both indoor and outdoor lighting controls.
 - 4. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time-based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
 - 5. System shall be capable of 'out of box' sequence of operation for each control zone.
 - 6. System shall interface with third party building management systems (BMS) to support two-way communication.

- D. System Software:
 - 1. System shall provide a web-based management interface that provides remote system control, live status monitoring and configuration capabilities of lighting control settings and schedules.
 - 2. All system software must be available for automatic download and installation via the internet.
- E. System Backbone and Integration Equipment:
 - 1. System Controller:
 - a. System controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power suppliers
 - b. Controller shall perform the following functions:
 - 1) Facilitation of global network communication between different areas and control zones.
 - 2) Time-based control of downstream wired network devices.
 - 3) Linking into an Ethernet network.
 - 4) Integration with Building Management Systems (BMS) and Heating, Ventilation, and Air Conditioning (HVAC) equipment.
 - 5) Connection to various software interfaces, including management interface, historical database, analytics interface and personal control applications.
 - 2. Device shall have a standard and astronomical internal time clock.

2.2 LIGHTING CONTROL DEVICES

- A. When intelligent lighting control units are specified, lighting control devices shall be from the same manufacturer and contain an addressable interface to allow each device to have its own unique address.
- B. Exterior Photocell Switches:
 - 1. Automatic ON/OFF switching photo control.
 - 2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
 - 3. Setting: ON at dusk and OFF at dawn.
 - 4. Time delay feature to prevent false switching.
 - 5. Field adjustable to control operating levels.
- C. Occupancy Sensor:
 - 1. General:
 - a. Capable of operating with lamp, ballasts, and drivers specified.
 - b. Readily accessible user adjustable controls for time delay and sensitivity.
 - c. Detection Range: 1000 square feet.
 - 2. Dual Technology:
 - a. Sensors use a combination of passive infrared and ultrasonic technologies to detect occupants in coverage area.
 - b. Provide technology mode selection to allow installer to configure the operation mode between dual technology, passive infrared only, or ultrasonic only functionality.
 - c. No audio dual technology units will be accepted.
 - 3. Sensor Mounting:

- a. Ceiling: Directional coverage 360 degrees.
 - b. Wall: Directional coverage 180 degrees.
 - c. Switch Box:
 - 1) Directional coverage 180 degrees.
 - 2) Coverage area: At desk top level up to 300 square feet and gross motion up to 1000 square feet.
 - 4. High Bay:
 - a. Directional coverage 360 degrees.
 - b. Mounting height: 12 feet to 50 feet.
 - c. Mounting: Conduit threads.
 - d. Bi-level switches turn lights on when occupant enters the coverage area and turns lights either off or to a preset dimmed level after coverage area is vacated for preset time delay.
- D. Daylight Sensor:
- 1. Photoelectric, low-voltage ambient light sensor (blue-enhanced photo diode).
 - 2. Compatible with dimming system.
 - 3. Field adjustable between 7 and 140 foot-candles.
- E. Time Switch for Building Exterior Lighting Control:
- 1. Astronomical dial.
 - 2. Bypass Switch: Prewired, externally operated ON/AUTO/OFF, for each circuit shown.
 - 3. Contact configuration and rating for circuits required.
 - 4. Enclosure: NEMA 250, Type 1
 - 5. Reserve power: Spring driven, capable of operating time switch for 16 hours after power failure.
 - 6. Wired for use with photocell specified.
 - 7. Alternatively: Exterior lighting control may be tied into intelligent lighting system.

- F. Timer switch for electrical, mechanical and utility rooms
 - 1. Tamper resistant with preset time-on interval.
 - 2. No minimum load requirement.
 - 3. Flicker of lights and/or beep warning at 2 minutes before count-down time elapses.
 - 4. Digital display of count down.
- G. Mechanically and Electrically Held Lighting Contactors: Refer to Section 26 29 16 Contactors for requirements.

2.3 DIMMING CONTROL

- A. When intelligent lighting control units are specified, lighting control devices shall be from the same manufacturer and contain an addressable interface to allow each device to have its own unique address.
- B. Programmable Dimming Control: Provide wall mounted, multichannel, multi-scene programmable dimming control module station with remote control capability and adjustable dimming fade rate for control of remote dimming modules. Refer to the drawings for project-specific dimming system requirements.
- C. Emergency Power Control Device: Provide UL 924 emergency control override device where emergency standby lighting is controlled locally. Provide 277-volt input voltage; interface controls, voltage presence sensing, internal automatic test; rate for up to 15-amp circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Verify finishes and location of exposed components and switches with the Contractor.
- C. Install lighting control panels to be accessible. Allow space for adequate ventilation and free circulation of air.
- D. Complete electrical connections to control circuits, network terminations, RS-232 connections, analog inputs, and override wiring.
- E. Building Exterior Luminaires: Photocells switch time clock ON at dusk with time clock switching lights OFF at preset time.
- F. Dimming Systems:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Do not connect ballasts or equipment to dimming system unless acceptable to dimming system manufacturer.
- G. Occupancy Sensors: Locate and aim sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per

manufacturer's recommendations. Provide 90 percent to 100 percent room coverage to accommodate all occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown on Drawings are diagrammatic and only indicate which rooms are to be provided with sensors. Provide additional sensors if required to properly and completely cover respective room.

- H. For intelligent lighting control system furnish manufacturer's representative at Job Site to inspect installation, test unit and put into service. Provide training as necessary to familiarize Owner's personnel with operation, use, adjustment, and problem-solving diagnosis of system.

3.2 FIELD QUALITY CONTROL

- A. Test relays and switches after installation to confirm proper operation.

3.3 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below (travel time excluded):
 - 1. 2 workdays for installation assistance and inspection of installation.
 - 2. 1 workdays for functional and performance testing.
 - 3. 1 workdays for plant startup.
 - 4. 1 workdays for instruction of site personnel.

END OF SECTION

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SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install the following low-voltage transformers:
 - 1. Dry-type, two-winding transformers.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. American National Standards Institute (ANSI).
 - 2. Authority having jurisdiction (AHJ).
 - 3. Code of Federal Regulations (CFR).
 - 4. National Electric Code (NEC).
 - 5. National Electrical Manufacturers Association (NEMA).
 - 6. National Fire Protection Association (NFPA).
 - 7. Underwriters Laboratories Inc. (UL).

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label or a label from a Nationally Recognized Testing Agency.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

- E. Manufacturer: Company specializing in low voltage transformers with 3 years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle equipment and store in accordance with manufacturer's instructions.
- B. Store in warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – DRY-TYPE, TWO-WINDING TRANSFORMERS

- A. Schneider Electric
- B. Eaton Corporation
- C. General Electric

2.2 DRY-TYPE, TWO-WINDING TRANSFORMERS

- A. Dry-type Transformers: National Electrical Manufacturers Association (NEMA) ST 20; factory-assembled, air-cooled, dry-type transformers; ratings as shown on drawings.
- B. Insulation system and average winding temperature rise for rated kVA as follows:

Rating	Insulation Class	Rise, Degrees C
15 kVA and below	185 degrees C	115
16 to 500 kVA	220 degrees C	150

- 1. Obtain required performance without exceeding above-indicated temperature rise in 40-degree C maximum ambient.
- C. Efficiency: minimum efficiency per Code of Federal Regulations 10 CFR 431.196
- D. Winding Taps, Transformers Less Than 15 kVA: Two 5 percent below-rated voltage, full-capacity taps on primary winding.
- E. Winding Taps, Transformers 15 kVA and Larger: NEMA ST 20.
- F. Transformers 75 kVA and Larger: Provide 4.5 percent minimum impedance.
- G. Sound Levels: NEMA ST 20.

- H. Basic Impulse Level: 10 kV.
- I. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
- J. Mounting: Transformers 75 kVA and less suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA suitable for floor or trapeze mounting.
- K. Coil Conductors: Aluminum Continuous windings with terminations brazed or welded.
- L. Enclosure:
 - 1. Case or enclosure shall be provided with a noncombustible moisture resistant case or enclosure that provides protection against the accidental insertion of foreign objects.
 - 2. NEMA ST 20, Type 1: Provide lifting eyes or brackets.
 - 3. Heavy-gauge steel with wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
 - 4. On units rated 15 kVA and below, totally enclosed, nonventilated, NEMA 3R, enclosure construction, with lifting eyes.
 - 5. On units rated 30 kVA and above, ventilated, NEMA 2, drip proof enclosure construction with lifting holes. Protect ventilation openings against falling dirt.
 - 6. Isolate core and coil from enclosure using vibration-absorbing mounts.
- M. Nameplate: Include transformer connection data.

2.3 FACTORY TESTING

- A. Perform the following standard factory tests on equipment provided under this Section. Test in accordance with latest version of American National Standards Institute (ANSI) and NEMA standards.
 - 1. Ratio tests at rated voltage connection and at tap connections.
 - 2. Polarity and phase relation tests on rated voltage connection.
 - 3. Applied potential tests.
 - 4. Induced potential test.
 - 5. No-load and excitation current at rated voltage on rated voltage connection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set transformer plumb and level.
- B. Use liquidtight, flexible conduit, 2-foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure. Reference Section 26 05 49 Vibration Isolation for Electrical Systems.

3.2 TRANSFORMER TAPS

- A. Set initial transformer taps up one tap to increase secondary voltage.
- B. At project completion measure primary and secondary voltages and adjust taps.
- C. Keep 120V outputs between 120-125V and 277V outputs between 277-290V.

3.3 FIELD QUALITY CONTROL

- A. Check for damage.
- B. Clean transformer of debris inside and out.
- C. Tighten connections prior to energizing transformer.

3.4 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 22 00-01	Catalog cut-sheets, other descriptive literature		Prior to delivery
26 22 00-08	Factory testing results		Prior to delivery
26 22 00-09	Operation and maintenance manuals		With operations and maintenance manuals

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install main switchboards.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating current (AC)
 - 2. Alternating current / direct current (AC/DC)
 - 3. American Wire Gauge (AWG)
 - 4. Asea Brown Boveri (ABB)
 - 5. Authority having jurisdiction (AHJ)
 - 6. Control power transformer (CPT)
 - 7. National Electric Code (NEC)
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. National Fire Protection Association (NFPA)
 - 10. Service entrance (SE)
 - 11. Synthetic Insulated Switchboard (SIS)
 - 12. Total harmonic distortion (THD)
 - 13. Underwriters Laboratories Inc. (UL)
 - 14. Volt alternating current (VAC)
 - 15. Volts direct current (VDC)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.

- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect switchboards from moisture by using appropriate heaters as instructed by the manufacturer.
- B. Deliver switchboard sections in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.
- C. Store switchboard sections in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle switchboard sections in accordance with National Electrical Manufacturers Association (NEMA) and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.6 EXTRA STOCK

- A. Spare Fuses: Provide two sets each spare fuses for each size and type.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Acceptable Manufacturers:
 - 1. Square D.
 - 2. Eaton.
 - 3. General Electric.
- B. Switchboard Construction and Ratings:
 - 1. Factory-assembled, dead-front, metal-enclosed, and self-supporting switchboard assembly complete from incoming line terminals to load-side terminations. Provide sections that align at front and rear. Provide side, top, front, and rear covers with removable captive screw-on plates having formed edges on sides. Provide front plates that are sectionalized, removable, made from steel with formed edges on sides.
 - 2. Enclosure: Type as per drawings.
 - 3. Switchboard Height: 90 inches nominal, excluding floor sills, lifting members, and pull boxes.
 - 4. Switchboard Ratings and Configuration:
 - a. Integrated Equipment Short-circuit Rating: As shown on the drawings.
 - b. Bus Voltage and Ampere Ratings: As shown on the drawings.
 - c. Configuration: As shown on the drawings and as listed on schedule.

- d. Frequency: 60 Hz.
 1. Service: Provide switchboards UL-labeled for use as SE equipment.
 5. Enclosure: NEMA Type 1[non-walk-in type] enclosure. Provide 120 VAC space heaters in each section.
 6. Provide stepdown transformer with overcurrent protection for heaters.
 7. Line Terminations: Accessible from the front of the switchboards.
 8. Load Terminations: Accessible from the front of the switchboards.
 9. Individually mount each main device.
 10. Group mount each distribution device.
 11. Isolate the sides of each compartment with steel barriers.
 12. Cable Entrance: Top.
 13. Auxiliary section for fire pump connection: Same construction as switchboard and located ahead of the main circuit breaker. Isolated compartment with lug connections to line side of main bus per NEC Article 695.
- C. Bus Work:
1. Bus Material: Silver-plated copper, sized in accordance with NEMA PB 2.
 2. Bus Connections: Bolted, accessible from front for maintenance. Provide complete bus, device supports, mounting, and connection for distribution devices shown as provision for future devices.
 3. Bus Arrangement: Phase A-B-C, left to right, top to bottom, and front to rear, as viewed from the front. Provide a main horizontal bus with a continuous current rating as shown. Provide main bus with full capacity through each section and with provisions for future extension.
 4. Where indicated, provide neutral bus extending the entire length of the switchboard of the same material as the main bus and a continuous current rating 100 percent of the main horizontal bus rating.
 5. Provide a 2-inch by ¼-inch tin-plated copper ground bus through the length of the switchboard, bolted to each vertical section. Provide a ground lug for one 4/0 AWG bare copper conductor on the bus.
- D. Mimic Bus: Show bussing, connections, and devices in single-line form on the front panels of the switchboard using red paint.
- E. Overcurrent Protective Devices:
1. Solid-State Molded-Case Circuit Breakers: Provide with true rms solid-state electronic programmer and positive flux-transfer trip device. Provide fixed mounted breakers, manually operated, main 100 percent rated, feeder's 80 percent rated. Provide operating handle capable of being padlocked in the off position. Provide breakers with the following trip functions:
 - a. Current Setting: Adjustable.
 - b. Long-time Pickup: Fixed.
 - c. Long-time Delay: Fixed.
 - d. Long-time timing light.
 - e. Short-time Pickup: Adjustable.
 - f. Short-time Delay: Adjustable.
 - g. Short-time delay I^2t ramp.
 - h. Instantaneous Pickup: Adjustable.
 - i. Ground Fault Pickup: Adjustable.
 - j. Ground Fault Delay: Adjustable.

- k. Residual type ground fault system.
 - 2. Molded-case Circuit Breakers: Provide circuit breakers, fixed mounted, with integral thermal trip. Provide fixed magnetic trip on 150-ampere and smaller frames; adjustable on 225-ampere and larger frames.
 - 3. Solid-state Digital Metering and Protection:
 - a. Microprocessor based, true rms sensing for measurement of electrical parameters, and auto range display of monitored functions. Provide the following minimum metering and protection features:
 - 1) Metering:
 - a) AC line current (per phase).
 - b) AC line-to-line voltage (three-phase).
 - c) AC line-to-neutral voltage (three-phase, four-wire).
 - d) Watts.
 - e) VARS.
 - f) Power factor.
 - g) Peak demand.
 - h) Frequency.
 - i) Watt hours.
 - j) Total harmonic distortion (THD).
 - 2) Monitor and Protection:
 - a) Voltage phase loss.
 - b) Current phase loss.
 - c) Voltage phase unbalance.
 - d) Phase reversal.
 - e) Undervoltage/overvoltage.
 - b. Provide data display at the unit by selecting individual parameters using a membrane push-button operator panel. Provide communication of measured data to a remote location over a two-wire network using standard equipment furnished with the system.
 - c. Provide alarm/trip indication by powering LEDs which show alarm or trip conditions.
 - d. Manufacturers: Cutler-Hammer IQ Data Plus 2 or equivalent GE, Square D, Power Measurements, or ABB.

F. Accessories:

- 1. Terminations: Provide long-barrel compression-type lugs suitable for copper conductors. Provide lugs suitable for 75 degree C-rated conductors.
- 2. Provide mechanical key interlocks where indicated on the drawings, interlocking as indicated.
- 3. Provide nameplates in accordance with Section 26 05 53 Identification for Electrical Systems.
- 4. Provide fitted spaces where indicated on the drawings.

G. Factory Finishes:

- 1. Clean surfaces before applying paint.
- 2. Apply corrosion-resistant primer to surfaces.
- 3. Apply finish coat of baked enamel paint to 3 mils thick.
- 4. Finish Color: Manufacturer's standard; Type 61, light gray.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchboard in locations shown on the drawings in accordance with manufacturer's written instructions.
- B. Secure switchboard securely to floor or mounting pads with anchor bolts, Philips Drill Company concrete anchors, or as required by manufacturer.
- C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- D. Provide nameplates in accordance with the requirements of
- E. Section 26 05 53 Identification for Electrical Systems for each individual circuit breaker that identifies its purpose or use.

3.2 NEUTRAL CONDUCTOR TERMINATIONS

- A. Terminate neutral conductors on individual terminals unless conductors are paralleled and terminals are rated for connection of more than one conductor.

3.3 ARC FLASH POTENTIAL

- A. Provide arc flash potential labeling per NEC, CEC and NFPA 70E.

3.4 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.
- C. Adjust trip and time-delay settings to values as indicated in Section 26 05 75 Fault Calculation and Protective Device Coordination Study.

3.5 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for 1 minute each at a test voltage of 1,000 Volts, and a minimum acceptable value for insulation resistance of 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Provide tightness in accordance with manufacturer's recommended values.

3.6 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below (travel time excluded):

1. 2 workdays for installation assistance and inspection of installation.
2. 2 workdays for functional and performance testing.
3. 2 workdays for plant startup.
4. 2 workdays for instruction of site personnel.

B. Manufacturer's Certification: Provide a qualified factory-trained manufacturer's representative to certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.

3.7 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 24 13-01	Sketch with maximum external dimensions.		Prior to delivery
26 24 13-02	Shipping weight.		Prior to delivery
26 24 13-03	Size and number of bus bars per phase, neutral, and ground.		Prior to delivery
26 24 13-04	Electrical characteristics including voltage, frame size, trip ratings, and integrated equipment short-circuit rating.		Prior to delivery
26 24 13-05	Include front and side views of enclosures with overall dimensions shown, including shipping splits.		Prior to delivery
26 24 13-06	Conduit entrance locations and requirements.		Prior to delivery
26 24 13-07	Switchboard instrument details, including complete schematic and wiring diagrams. Instructions for handling and installation of switchboard.		Prior to delivery
26 24 13-08	Written verification of the power company's approval of the design.		Prior to delivery
26 24 13-09	Provide 3 certified copies of factory test reports prior to shipment.		With operations and maintenance manuals
26 24 13-10	3 copies of the manufacturer's representative's field certification.		With operations and maintenance manuals

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 24 13-11	Maintenance instructions for cleaning methods, cleaning materials recommended, instructions for circuit breaker removal, replacement, testing and adjusting, and		With operations and maintenance manuals
26 24 13-12	Record drawings including a front view, plan view, elementary diagram, device summary, and complete wiring diagrams.		Prior to delivery

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch circuit panelboards.
- B. Panelboard Types and Classes

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority Having Jurisdiction (AHJ)
 - 2. National Electric Code (NEC)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters Laboratories Inc. (UL)
- B. References Standards:
 - 1. National Electrical Manufacturers Association (NEMA) 250
 - 2. NEMA PB1
 - 3. National Fire Protection Association (NFPA) 70
 - 4. Underwriters Laboratories Inc. (UL) 489
 - 5. UL 67
 - 6. Federal Specification - W-P-115C Panel, Power Distribution.

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.

- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- E. Ensure the manufacturer of the assembly is the manufacturer of the major components within the assembly and has produced similar electrical equipment for a minimum period of 5 years.

1.5 SPARE PARTS

- A. Keys: Furnish two for each panelboard to Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES – PANELBOARDS

- A. Square D.
- B. Eaton.
- C. General Electric Company.

2.2 DISTRIBUTION PANELBOARDS

- A. Panelboards:
- B. Type I, Class 1 Circuit Breaker type.
- C. Enclosure: National Electrical Manufacturers Association (NEMA) PB 1, Type 1; cabinet size, 9 1/2" inches deep, 26 inches wide (minimum).
- D. Provide cabinet front with screw cover and hinged door with flush lock. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings on drawings. Provide copper ground bus in panelboards.
- F. Minimum Integrated Short-circuit Rating: 10,000 amperes rms symmetrical for 208 Volt panelboards; 22,000 amperes rms symmetrical for 480 Volt panelboards or as shown on drawings. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
- G. Molded-case Circuit Breakers: Provide bolt-on-type circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL-listed as

- H. Type HACR for air-conditioning equipment branch circuits. Handle lockable in off position.
- I. When indicated, provide 100 percent rated circuit breakers.
- J. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 200 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
- K. Terminations: Provide mechanical setscrew compression-type lugs suitable for copper conductors. Provide lugs suitable for 75-degree C rated conductors.
- L. Provide panelboard and individual device nameplates in accordance with Section 26 05 53 Identification for Electrical Systems.

2.3 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: Type I, Class 1 Circuit Breaker type.
- B. Enclosure: Type 1.
- C. Cabinet Size: 5 3/4 inches deep; 20 inches wide.
- D. Provide surface cabinet front with typewritten directory, trim clamps, hinged door and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings on drawings. Provide copper ground bus in panelboards.
- F. Minimum Integrated Short-circuit Rating: 10,000 amperes rms symmetrical for 208 Volt panelboards; 14,000 amperes rms symmetrical for 480 Volt panelboards or as shown on drawings.
- G. Molded-case Circuit Breakers: [Bolt-on-type thermal magnetic trip circuit breakers with common trip handle for all poles. Provide circuit breakers UL-listed as Type SWD and HID for lighting circuits. Provide UL, Class A, ground fault interrupter circuit breakers where scheduled on drawings. Provide 30 mA ground fault interrupter circuit breakers for heat trace loads. Provide circuit breakers UL-listed as Type HACR for air-conditioning equipment branch circuits. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
- H. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 100 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
- I. Terminations: Provide mechanical setscrew compression-type lugs suitable for copper conductors. Provide lugs suitable for 75-degree C rated conductors.
- J. Nameplates: Laminated plastic with engraved letters on each unit. See Section 26 05 53 Identification for Electrical Systems.

- K. Provide standard circuit inventory holders.
- L. Refer to panel schedules on the drawings for specific requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb, vertical unless impractical, and in conformance with NEMA requirements.
- B. Height: 78 inches to top.
- C. Adjust trim to cover openings.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Stub five empty 1-inch conduit to accessible location above ceiling out of each recessed unit.

3.2 FIELD QUALITY CONTROL

- A. Measure steady-state load currents at each panelboard feeder. Where the difference at any panelboard between phases exceed 20 percent, rearrange circuits to balance the phase loads within 20 percent. Take care to maintain proper phasing for multiwire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

3.3 PROTECTION DURING CONSTRUCTION

- A. Store products specified in this Section in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction.

3.4 GROUND BUS INSTALLATION

- A. Install ground bus in accessible location.
- B. Ground wires to be taken to individual terminals unless terminals are parallel rated.

3.5 ARC FLASH POTENTIAL

- A. Provide arc flash potential warning labeling on equipment in accordance with NEC.

3.6 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 24 16-01	Characteristics, including dimensions, enclosure type, weight, outline and support point dimensions, main bus ampacity, integrated short-circuit current rating, circuit breaker and fusible switch arrangement, and sizes.		Prior to delivery
26 24 16-06	Operation and maintenance instructions including descriptive bulletins.		With operations and maintenance manuals
26 24 16-07	Test results		Provide factory testing results per UL 67.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Wall switches.
 - 2. Wall dimmers.
 - 3. Receptacles.
 - 4. Floor-mounted service fittings.
 - 5. Device plates and box covers.
 - 6. Cords and caps.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating current (AC).
 - 2. American Disabilities Act (ADA).
 - 3. Arc fault circuit interrupter (AFCI).
 - 4. Authority having jurisdiction (AHJ).
 - 5. Corrosion-resistant (CRE).
 - 6. Ground fault circuit interrupter (GFCI).
 - 7. Leakage current detection and interruption (LCDI).
 - 8. National Electric Code (NEC).
 - 9. National Electrical Manufacturers Association (NEMA).
 - 10. National Fire Protection Association (NFPA).
 - 11. Transient voltage surge suppression (TVSS).
 - 12. Underwriters Laboratories Inc. (UL).
 - 13. Single Pole Single Throw (SPST).
 - 14. Double Pole Double Throw (DPDT).

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally

recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.

- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Wall Switches:
 - 1. Bryant.
 - 2. General Electric.
 - 3. Hubbell.
 - 4. Leviton.
 - 5. Pass and Seymour.
 - 6. Eagle.
 - 7. Arrow Hart.
 - 8. Crouse-hinds/Appleton/Killark for classified area installation.
- B. Wall Dimmers: Refer to Section 26 09 23 – Lighting Control Devices
- C. Receptacles:
 - 1. Bryant.
 - 2. General Electric.
 - 3. Hubbell.
 - 4. Leviton.
 - 5. Pass and Seymour.
 - 6. Eagle.
 - 7. Arrow Hart.
 - 8. Crouse-hinds/Appleton/Killark for classified area installation.
- D. Floor-Mounted Service Fittings:
 - 1. Legrand
 - 2. Bryant.
 - 3. General Electric.
 - 4. Hubbell.
 - 5. Leviton.
 - 6. Pass and Seymour.
- E. Device Plates and Box Covers:
 - 1. Bryant.
 - 2. General Electric.

3. Hubbell.
4. Leviton.
5. Pass and Seymour.
6. Eagle.
7. Arrow Hart.

- F. Cords and Caps:
1. Hubbell.
 2. Leviton.
 3. Pass and Seymour.
 4. Arrow Hart.

2.2 MATERIALS

- A. Wall Switches:
1. Wall Switches (SPST, DPST, three or four way) for Lighting Circuits and Motor Loads Under 1/2 Horsepower: National Electrical Manufacturers Association (NEMA) WD 1; alternating current (AC) general-use snap switch with rocker handle, rated 20 amperes and 120 to 277 VAC, screw-type terminals. White in all areas. Weatherproof: Switches as specified mounted in cast metal box with gasketed, weatherproof device plate as specified.
- B. Receptacles:
1. Convenience and Straight-blade Receptacles: NEMA WD 1.
 2. Locking-blade Receptacles: Type indicated on drawings.
 3. Convenience Receptacle Configuration: Type 5-20R.
 - a. Nylon Face White in all areas.
 4. Weatherproof Receptacles: Receptacles as specified mounted in cast steel box with gasketed, weatherproof device plate as specified.
 5. Ground Fault Circuit Interrupter (GFCI) Receptacles: Duplex convenience receptacle with integral GFCI c/w nominal sensitivity level of 5 mA on the load side and tripping time of 1/30th of a second, NEMA Type 5-20R. Feed-through type for downstream device protection.
 6. Specific-purpose Receptacles:
 - a. Configuration: Type as indicated on drawings, nylon face.
 - b. Pin-and-Sleeve Type: Number of poles and wires as indicated on drawings. Provide back boxes where indicated. Provide gasketed cover and watertight sealing glands. Provide matching plug with cord-grip features for each receptacle.
 - c. Twist-lock Type: NEMA configuration as shown on the drawings. Provide one matching plug with cord-grip feature for each receptacle.
- C. Floor-mounted Service Fittings:
1. Flush Covers for Duplex Convenience Receptacle: Brass flush cover suitable for floor box with duplex threaded opening. Provide brass-finish protective rings for use with threaded openings. Provide brass carpet rings.
 2. Flush Covers for Communications: Brass flush cover suitable for floor box, with 2-1/8- by 1-inch combination threaded opening. Provide brass-finish protective rings . Provide brass carpet rings.

- D. Device Plates and Box Covers:
 - 1. Decorative Cover Plate: Smooth Satin-finish smooth stainless steel.
 - 2. Cast Metal Plates: Use with cast metal box. Use steel plates with steel boxes and copper-free aluminum with aluminum boxes. Provide stainless steel screws.
 - 3. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device covers.
- E. Cords and Caps:
 - 1. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
 - 2. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for extra-hard usage in damp locations.
 - 3. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall switches 48 inches above floor, off position down.
- B. Install convenience receptacles 18 inches above, grounding pole on bottom. Install receptacles over counters at heights shown on drawings.
- C. Install specific-use receptacles at heights shown on drawings.
- D. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.
- E. Corridor Convenience Receptacles: Hospital grade.
- F. Install decorative cover plates on switches, receptacles, and blank outlets in finished areas. Use jumbo-size plates for outlets installed in masonry walls.
- G. Install cast metal or galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- H. Install devices and wall plates flush and level.
- I. Install prefinished cord set where connection with attachment plug is indicated or specified or use attachment plug with suitable strain-relief clamps.
- J. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 27 26-01	Catalog cutsheets, other descriptive literature		Prior to delivery

END OF SECTION

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SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Enclosed low-voltage circuit breakers for main feeders and branch circuit protection.
 - 2. Disconnect switches for service/motor and equipment disconnecting means.
 - 3. Fuses.
 - 4. Enclosures.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. frequency drive (VFD)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 SPARE PARTS

- A. Fuses: Furnish to Owner 2 sets of spare fuses of each type and rating installed.
- B. Fuse Pullers: Furnish 2 fuse pullers to Owner.

1.5 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Square D.
- B. Eaton.
- C. General Electric.

2.2 MATERIALS

- A. Individually Mounted Enclosed Low-voltage Circuit Breakers:
 - 1. Enclosure:
 - a. Heavy duty National Electrical Manufacturers Association (NEMA) Type as indicated on drawings.
 - b. Provide surface-mounted box with door; interlock door with circuit breakers so door may not be opened when circuit breaker is in closed position. Provide defeater so qualified personnel can open door when circuit breaker is in closed position. Provide ability to lock breaker in open position.
 - c. Finish: Provide manufacturer's standard gray enamel.
 - 2. Minimum Integrated Short-circuit Rating: 10,000 amps rms symmetrical for 208 Volt and 14,000 amps rms symmetrical for 480 Volts/600 Volts. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
 - 3. Molded-case Circuit Breakers: Bolt-on-type thermal magnetic trip with inverse time-current element for overload tripping and instantaneous magnetic trip circuit breakers complete with common trip handle for all poles; Class 1. Circuit breaker frame size equal to 250 A or larger to have adjustable magnetic trip setting and to be front mounted. Electronic trip unit circuit breaker to be RMS sensing c/w field replaceable rating plug and followings: instantaneous/long- and short-time delay adjustments, pickup levels and time delayed ground fault adjustable pickup levels. Provide UL, Class A, ground fault circuit interrupter (GFCI) breakers where shown on drawings. Provide 30 mA GFCI breakers for heat trace loads protecting equipment, 5mA trip sensitivity for personnel safety. Provide circuit breakers listed as Type HACR for air conditioning branch circuits and
 - 4. Types SWD and HID for lighting circuits.
 - 5. Do not use tandem circuit breakers or single-pole units with handle ties where two- or three-pole units are indicated.
 - 6. Terminations: Provide hardware as required to accommodate type of connectors specified in Section 26 05 19 Low-voltage Electrical Power Conductors and Cables.
 - 7. Nameplates: Provide laminated plastic nameplates with engraved letters on each unit in accordance with Section 26 05 53 Identification for Electrical Systems.
 - 8. Finish: Provide manufacturer's standard gray enamel.
 - 9. Shunt trip: 120 Volt trip coil energized from separate control circuit, set to trip at 55 percent rated voltage.

- B. Disconnect Switches:
 - 1. Fusible Switch Assemblies: 800 A or less, quick-make, quick-break, load-interrupter, Type HD, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position; fuse clips designed to accommodate current-limiting Class R fuses.
 - 2. Non-fusible Switch Assemblies: Type HD; quick-make, quick-break, load-interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position.
 - 3. Enclosures: Type 1 or as indicated on drawings].
 - 4. Terminations: Provide hardware as required to accommodate type of connectors specified in Section 26 05 19 Low-voltage Electrical Power Conductors and Cables.
 - 5. Nameplates: Provide laminated plastic nameplates with engraved letters on each unit in accordance with Section 26 05 53 Identification for Electrical Systems.
 - 6. Finish: Provide manufacturer's standard gray enamel.
- C. Fuses:
 - 1. See Section 26 05 05 Basic Electrical Materials and Methods, for detailed specifications.
 - 2. Fuses 600 Amperes and Less: Class RK5 for low-voltage motors as indicated on drawings; current-limiting, time-delay, one-time fuse, 600 Volts.
 - 3. Interrupting Rating: 200,000 rms amperes.
- D. Enclosure nameplates for electrical system identification in accordance with Section 26 05 53.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install circuit breakers and disconnect switches where indicated on drawings.
- B. Install fuses in fusible disconnect switches.
- C. Individually Mounted Enclosed Circuit Breakers and Disconnect Switches:
 - 1. Install enclosures plumb.
 - 2. Maximum Height: Top of enclosure at 78 inches AFF.
 - 3. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check for proper installation and tightness of connections.
 - 4. Mount vertical unless approved by Owner.

3.2 FIELD QUALITY CONTROL

- A. Factory-authorized service representative to perform full visual inspection, provide adjustment and assist on field testing on electrical and mechanical connections.

- B. Perform Megger insulation and continuity tests on each switch, circuit breaker, components and control circuit.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 28 16-01	Catalog cutsheets, other descriptive literature		Prior to delivery
26 28 16-02	Physical characteristics, including dimensions, enclosure type, openings		Prior to delivery
26 28 16-04	Electrical characteristics for breakers including voltage, frame size, trip rating, integrated short-circuit rating		Prior to delivery

END OF SECTION

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install enclosed controllers not installed in motor control centers (MCCs), including:
 - 1. Manual motor starters.
 - 2. Magnetic motor starters (including-soft starters)
 - 3. Combination magnetic motor starters.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating current (AC)
 - 2. Authority having jurisdiction (AHJ)
 - 3. Direct current (DC)
 - 4. Distributed Control System (DCS)
 - 5. Energy-efficient (EF)
 - 6. Light emitting diode (LED)
 - 7. Motor control center (MCC)
 - 8. Motor circuit protectors (MCPs)
 - 9. National Electric Code (NEC)
 - 10. National Fire Protection Association (NFPA)
 - 11. Programmable Logic Controller (PLC)
 - 12. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.

- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Square D.
- B. Eaton.
- C. General Electric.

2.2 MANUAL MOTOR STARTERS

- A. Integral Horsepower Motor Starter: Size and poles as indicated on drawings; AC, general purpose, Class A, manually operated, non-reversing, full-voltage controller for induction motors rated in horsepower. Provide field-convertible manual/automatic overload reset feature factory set in manual reset mode. Class 10- or 20-type ambient compensated relay with adjustable (90 to 110 percent of respective rating) trip. Provide with SPST NC contact. Bimetallic type thermal elements. Provide red (run) green (off) transformer-type light emitting diode (LED) pilot lights and toggle operator with provisions for padlock.
- B. Fractional Horsepower Manual Motor Starter: Horsepower rating and poles as indicated on drawing; AC, general purpose, Class A, manually operated full-voltage controller for fractional horsepower induction motors with adjustable thermal overload unit (bimetallic heaters). Provide red (run) green (off) transformer-type LED pilot lights and toggle with provisions for padlock operator.
- C. Enclosure: Type 1 unless indicated otherwise on drawings.

2.3 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: AC, general purpose, Class A, magnetic controller for induction motors rated in horsepower, Size 1 minimum.
- B. Full voltage Starting: Non-reversing, and type as indicated on drawings.
- C. Provide manufacturer's standard schematic and wiring. Control circuit is 120 Volts fed from integral CPT at the starter completed with secondary fuses.

- D. Coil Operating Voltage: 120 Volts 60 Hz.
- E. Size: As indicated on drawings.
- F. Overload Relay: Provide with manual overload reset Class 20-type ambient compensated relay with adjustable (90 to 110 percent of respective rating) trip. Provide with one
- G. SPST NO contact. Electronic type elements. Solid state overload relay to be selected against single phasing and voltage/current unbalance. If ground fault protection required for motor and feeder protection, solid state overload relay with ground fault protection will be used.
- H. Enclosure: NEMA 1, unless indicated otherwise on drawings.
- I. Combination Motor Starters: Factory assembled combined motor starters with disconnecting means indicated on drawings. Circuit breaker to be HMCP with field adjustable short circuit trip, settings to be coordinated with motor LRC.
- J. Auxiliary Contacts: Minimum two normally open and two normally closed field convertible contacts in addition to seal-in contact, or as indicated on drawings.
- K. Front Cover Control Devices: Heavy-duty, NEMA 13 control and indicating devices for NEMA 1 and 12 enclosures. Provide heavy-duty NEMA 4 type devices for NEMA 4 enclosures. Provide corrosion-resistant type for NEMA 4X applications as indicated on drawings. Type indicated on drawings.
- L. Indicating Lights: Transformer LED-type mounted in front cover. Lens color(s), red run, green stop. Push-to-test-type indicating lights.
- M. Relays: Type indicated on drawings.
- N. Control Power Transformers: Secondary voltage as indicated on drawings, 100 VA minimum, unless indicated otherwise on drawings; protection as indicated on drawings.

2.4 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTION MEANS FOR COMBINATION STARTER

- A. Motor Circuit Protector (MCP): Circuit breakers with integral instantaneous magnetic trip in each pole. Provide interlock to prevent opening front cover with MCP in on position defeatable with screwdriver. Interrupting rating (starter as an assembly) as indicated on drawings. Handle lockable in off position. Where required to achieve specified short-circuit rating, provide current-limiter attachment rated at 100,000 amps rms symmetrical interrupting current.
- B. Molded-case, Thermal-magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide interlock to prevent opening front cover with circuit breaker in on position defeatable with screwdriver. Handle lockable in off position. Interrupting rating (as an assembly) as indicated on drawings. Where required to achieve specified short-circuit rating, provide current-limiter attachment rated at 100,000 amps rms symmetrical interrupting current.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible switches.
- B. Select and install overload relay elements in motor starters based on actual motor nameplate ratings, such as full-load current, service factor, temperature rise, and ambient motor temperature. Coordinate with starter vendor to obtain starters early for install and overloads later when actual motor full load current is known.
- C. Motor Data: Provide self-adhesive, typed label attached inside each motor starter enclosure door identifying motor served by tag number and equipment name, nameplate horsepower, full-load amperes, motor code letter, service factor, and installed overload relay element catalog number.
- D. Set MCPs to minimum trip setting that will permit motor starting under normal conditions using procedures outlined in manufacturer's instructions booklet.
- E. Provide nameplates in accordance with Section 26 05 53 Identification for Electrical Systems. Add lamacoid of warning sign for multiple voltage sources inside the enclosure if automation control and interface is required.
- F. Mounting height is 5 feet (1500 mm) to the operating handle.
- G. Use HOA mounted on the front of enclosure for automated Programmable Logic Controller (PLC) / Distributed Control System (DCS) remote control and shutdown.
- H. Ground and bonding on equipment to be completed, as per NEC Article 250 or CEC Section 10 Grounding and Bonding.
- I. Identify components/wire tags on control/field wiring and terminal blocks at the enclosed controller.

3.2 TESTING

- A. Manufacturer's field services to provide on-site test and adjustment on the solid-state controller to ensure the controller fully functional to operate the equipment.
- B. Acceptance test by field contractor to perform the Megger insulation test for enclosed controller/components/wiring on the control circuit.

3.3 ARC FLASH POTENTIAL

- A. Provide arc flash potential labeling on equipment per NEC and NFPA 70E.

3.4 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 29 13-01	Catalog cutsheets, other descriptive literature on motor starters, relays, control transformers, control devices, and overcurrent devices		Prior to delivery
26 29 13-05	Wiring and schematic diagrams that identify devices, indicate connections, and identify terminal numbers (note devices furnished when options involved)		Prior to delivery
26 29 13-08	Operation and maintenance manuals		With operations and maintenance manuals

END OF SECTION

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SECTION 26 29 16

CONTACTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes contactors for general-purpose use and lighting control.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating Current (AC)
 - 2. Authority having jurisdiction (AHJ)
 - 3. Direct Current (DC)
 - 4. National Electric Code (NEC)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. National Fire Protection Association (NFPA)
 - 7. Occupational Safety and Health Act (OSHA)
 - 8. Underwriters Laboratories Inc. (UL)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Contactors:
 - 1. Square-D.
 - 2. Eaton.
 - 3. General Electric.
 - 4. ASCO.
 - 5. Allen-Bradley.

2.1 MATERIALS:

- B. General:
 - 1. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts Alternating Current (AC) or 750 Volts Direct Current (DC).
 - 2. Mechanically held, electrically operated contactors with size and number of poles as indicated on drawings.
- C. Coils: Encapsulated and rated for operation at 120Volts, 60Hz.
- D. Contacts: Fully rated, totally enclosed, silver plated, capable of inspection or replacement without disturbing line or load wiring.
- E. Enclosures:
 - 1. NEMA 1 for dry, indoor non-manufacturing areas.
 - 2. NEMA 4X for damp or outdoor locations.
- F. Pushbuttons, Selector Switches, and Indicating Lights:
 - 1. Pushbuttons: Momentary contact type with flush head unless indicated otherwise on drawings.
 - 2. Selector Switches: Number of positions in rotation action (H/A or H/O/A) as indicated on drawings. Where a "Test" (Hand) or similar momentary position is required, provide switch unit with spring return from momentary position to "Off" and maintained in "Auto".
 - 3. Indicating Lights: Transformer type with six-volt incandescent lamps and interchangeable color caps. Specific colors are indicated on drawings.
 - 4. Auxiliary contacts: One NO and one NC field convertible contacts in addition to holding contact.
 - 5. Control Power Transformer: 120 Volts secondary furnished with fuse and bond the unfused leg of secondary to equipment ground.
 - 6. Combination contactors: Contactors to be installed with thermal magnetic circuit breaker (integral thermal and instantaneous magnetic trip).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount enclosures plumb and level, 6 feet x 6 inches to top, and rigidly attach to structure using materials and methods specified in Section 26 05 29 Hangers and Supports for Electrical Systems.
- B. Install surface mounted units in a manner to permit vertical flow of air behind cabinets and enclosures.
- C. Install incoming and outgoing power and control circuits in accordance with Section 26 05 19 Low-voltage Electrical Power Conductors and Cables.
- D. Check interconnection and operation of control devices, interlocks, indicating lights, and control relays. Set timers and time delay relays for correct intervals. Check contactor-operating coil for correct voltage rating.

3.2 IDENTIFICATION

- A. Comply with Section 26 05 53 Identification for Electrical Systems.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 29 16-01	Submit Product Data on each contactor including: • Dimensions. • Voltage and number of poles. • Current ratings and NEMA size. • Enclosure type and accessories.		Prior to delivery

END OF SECTION

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SECTION 26 32 13

ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary for the new Laboratory and Maintenance Building only to furnish and install:
 - 1. Engine generator system.
 - 2. Radiator.
 - 3. Exhaust silencer and fittings.
 - 4. Subbase fuel tank and fittings.
 - 5. Generator control/alarm panels.
 - 6. Battery and charger.
 - 7. Weatherproof sound-attenuating enclosure.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating Current (AC)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society of Civil Engineers (ASCE)
 - 4. Authority having jurisdiction (AHJ)
 - 5. Automatic transfer switch (ATS)
 - 6. Diesel Engine Manufacturer's Association (DEMA)
 - 7. Direct current (DC)
 - 8. Electrical Equipment Manufacturers Association of Canada (EEMAC)
 - 9. International Building Code (IBC)
 - 10. National Electric Code (NEC)
 - 11. National Electrical Manufacturers Association (NEMA)
 - 12. National Fire Protection Association (NFPA)
 - 13. Telephone Influence Factor (TIF)
 - 14. Underwriters Laboratories Inc. (UL)
 - 15. Uninterruptible Power Supply (UPS)
- B. References Standards:
 - 1. National Electrical Manufacturers Association (NEMA) MG-1 – Motors and Generators.
 - 2. NEMA MG-2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.
 - 3. Listed to UL 2200 – Stationary Engine Generator Assemblies.
 - 4. Wind Design Requirements: The enclosure/housing, the internal support structure, and the anchorage of all electrical equipment, and associated raceways shall be designed and constructed to withstand the stresses produced by wind forces as defined in and required by the IBC, 2015 Edition. The following criteria are applicable to this project.
 - a. Ultimate Design Wind Speed, $V_{ult} = 115\text{MPH}$

- b. Nominal Design Wind Speed, $V_{asd} = 89$ MPH
 - c. Exposure Category C.
- 5. Emissions and Noise Requirements: Provide equipment that complies with emission and noise requirements applicable to the project site located in Arlington, Texas.
- 6. Guarantee: Manufacturer to guarantee the entire system to be in accordance with nameplate specifications and to be free from defects in material and workmanship under normal use for a minimum of 2 years from the date the system is put into service.

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label or a label from a Nationally Recognized Testing Agency.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- E. Manufacturer: Company specializing in engine generators with 3 years' documented experience.

1.5 SYSTEM DESCRIPTION

- A. Engine Generator System: Provide optional standby power source.
- B. System Capacity: Each unit kW and kVA as indicated on the drawings; standby rating using engine-mounted radiator and No. 2 fuel oil.
- C. Operation: Operate in automatic mode in conjunction with automatic transfer switch(es) as described herein.
 - 1. Upon loss of normal source voltage (below 70 to 90 percent adjustable) and after adjustable 0.5 to 10 second time delay to allow for momentary dips, close engine starting contacts to start engine generator.

2. Automatic Emergency Load Acquisition Sequence Time: Maximum 10 seconds from utility normal power source failure.
3. Upon restoration of normal voltage and frequency (phases greater than
4. 90 percent of nominal) and after 0 to 25-minute adjustable time period, retransfer back to normal.
5. After loads have been removed, continue to operate engine generator unloaded for 0 to 30 minutes adjustable for engine cool down.

1.6 DESIGN CRITERIA

A. Reliability Tests:

1. Certified Factory Equivalent Model Tests: Test power generation system consisting of prime mover, generator, and necessary controls as complete systems on representative engineering prototype models. Do not perform tests on equipment sold but on separate production models. Certify that this prototype testing has been accomplished. Include:
 - a. Maximum power level (maximum kW).
 - b. Maximum motor starting capacity (maximum kVA).
 - c. Structural soundness.
 - d. Torsiograph Analysis per MIL-STD 705C, Method 504.2: Calculate torsional analysis using data from actual tests by generator set manufacturer to verify freedom from torsional stresses within plus or minus 10 percent of rated speed. Make results available to Owner for inspection upon request. Perform actual torsional fatigue test on complete prototype generator set. Do not base calculations on engine and generator data separately.
 - e. Engine alternator cooling airflow.
 - f. Transient response and steady-state governing.
 - g. Alternator temperature rise by resistance method.
 - h. Harmonic analysis and voltage waveform deviation according to MIL-STD 705C, Method 601.4.
 - i. Three-phase, Short-circuit Test for Mechanical and Electrical Strength: With system operating at rated volts, amps, power factor, and speed, short-circuit generator terminals ten times on all three phases for
 - j. 10 seconds. Demonstrate that generator set builds up and performs normally without manual intervention, such as resetting of circuit breakers or other tripping devices when short circuit is removed.
 - k. Perform endurance testing at rated load and speed without significant damage or failures of electrical or mechanical components.
2. Sound generation at octave bands in accordance with ISO 8528-10.
 - a. Parallel Test: Demonstrate that representative prototype generator sets are capable of withstanding 120 degree out-of-phase paralleling from full-rated voltage and speed without sustaining mechanical or electrical damage.
3. Certified Factory Production Model Tests: Before shipment of equipment, test generator and system components under rated load and power factor for performance and proper functioning of control and interfacing circuits. Do not test at unity power factor only (resistance banks only). Other tests:
 - a. Single-step load pickup.
 - b. Transient response and steady-state governing.
 - c. Alternator temperature rise by resistance method.

- d. Functional compatibility between generator set controls and master controls.
 - e. Fuel consumption.
- 4. Notify Owner in advance of these tests. Allow Owner to witness these tests. Forward certified copies of test results to Owner for review prior to shipment.
- 5. General testing requirements as outlined in NEMA MG-1 and MIL-STD 705C.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect generator and accessories from moisture by using appropriate heaters as instructed by manufacturer.
- B. Store generator and accessories in clean, dry space. Maintain wrapping or provide additional heavy canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- C. Handle generator and accessories in accordance with NEMA and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cummins.
- B. Caterpillar.
- C. Kohler.
- D. MTU Onsite Energy.

2.2 ENGINE

- A. Directly connected to generator by semiflexible coupling. Mount both on common subbase.
- B. Type: Water cooled in line or V type, four-stroke cycle, electric ignition internal combustion engine with removable wet-type cylinder liners.
- C. Fuel System: Appropriate for use of No. 2 fuel oil (ASTMD396).
- D. Governed Engine Speed: 1,800 rpm at 60 Hz.
- E. Governor:
 - 1. Isochronous type for parallel operation. Maintain engine speed within plus or minus 0.5 percent, steady state, and meet ISO 8528 Class 2 response criteria from no load to full load. Include actuator, governor control module, separate magnetic pickup (do not use to operate other devices besides governor), idle/run switch for warmup after maintenance, three-phase isochronous load-sharing module, and

auto synchronizer; integrated into engine generator control panels by panel manufacturer.

- F. Safety Devices: Engine shutdown on high jacket water temperature, low lubricating oil pressure, engine overspeed, and engine over crank. Limits as selected by manufacturer.
- G. Engine Starting: Direct current (DC) starting system with positive engagement. Number and voltage of starter motors in accordance with manufacturer's instructions of sufficient capacity to start engine within ambient temperatures between 30- and 100-degrees F within specified time period. Include remote starting control circuit with manual-off-remote selector switch on engine generator control panel.
- H. Engine Jacket Heater: Two independent immersion-type water heater with integral thermostatic control, sized to maintain engine jacket water at normal engine operating temperature and suitable for operation on a 20 A, three-phase, 208 Vac circuit.
- I. Attached Radiator:
 - 1. Radiator using solution of 50 percent ethylene-glycol extended life coolant with blower-type fan, sized to maintain safe engine temperature when generator is fully loaded at ambient temperature and altitude specified. Radiator Airflow Restriction: 0.5-inch WC, maximum.
 - 2. Provide engine-mounted cooling radiator with blower fan and Venturi shroud. Provide rigid guard to close both top and sides of moving parts between engine and radiator.
- J. Engine Accessories:
 - 1. Fuel Strainer and Filter: Mount between engine fuel pump and engine. Provide water/fuel separator/fuel strainer in line with fuel filter.
 - 2. Lube Oil Filter: Conveniently located for servicing. Equip with spring-loaded bypass valve to ensure oil circulation if filters are clogged. Provide oil drain extension line positioned to permit convenient servicing of unit as installed. Provide bayonet-type oil level stick.
 - 3. Intake Air Filter: Heavy-duty, dry-type, replaceable element type rated for normal service.
 - 4. Fuel Transfer Pump: Positive-displacement engine-driven type. Provide relief valve to prevent excessive pressure buildup if discharge line becomes clogged.
 - 5. Fuel Priming Pump: Positive displacement priming pump.
 - 6. Water Pump: Engine-driven centrifugal type with thermostatic valve to maintain engine at recommended temperature level.
 - 7. Lubricating Oil Pump: Gear type for supplying oil under predetermined constant pressure to main bearings, pistons, piston pins, timing gears, camshaft bearings, and valve mechanism.
 - 8. Engine-Mounted Gauges: Provide control panel on engine with the following gauges to monitor engine operation:
 - a. Lubrication and pressure gauge.
 - b. Cooling water temperature gauge.
 - c. Lubrication oil temperature gauge.
 - 9. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal toolbox.
 - 10. Provide two additional sets of each fuel, oil, and air filter element required for engine generator system.

11. Provide motor starters for engine accessories prewired from factory.
- K. Vibration Isolation:
 1. Meet applicable Diesel Engine Manufacturer's Association (DEMA) vibration standards.
 2. Use vibration analytical techniques to determine shaft critical speeds and to develop bearing design and shaft balancing to mitigate vibration.
 3. Apply torsional analysis and design to mitigate torsional vibration.
 4. Engine and Generator Individually: Do not exceed 10 mils vibration in any plane at continuous rating point when measured at attachment points to common steel subbase.
 5. Mount engine and generator on common structural steel frame sufficiently rigid to prevent deflection between vibration isolators.
 6. Demonstrate freedom from torsional vibration by torsional analysis.
 7. Isolate complete subbase from enclosure skid base Korfund Series L vibration isolators, sized by isolator manufacturer. Limit vibration transmissibility to 10 percent maximum.
 8. Integral Sub-base Fuel Tank: Sized for 12-hour run time, 12-gauge steel, welded, with internal baffles, double-contained. Provide fuel cap with padlock provisions, extended vent, fuel gauge, fill pipe, and hoses and connectors for complete system.

2.3 GENERATOR

- A. Generator: Reconnectable brushless, revolving field type, coupled directly to engine flywheel through flexible driving disc for positive alignment. Directly bolt generator housing to engine flywheel housing. Provide generator housing with single ball bearing support for rotor.
- B. Rotor: Layer wound with thermosetting epoxy between each layer plus final epoxy coat for moisture and abrasion resistance. Provide amortisseur windings integral with rotor coil support, sealed bearings. Design bearing for minimum B-10 40,000-hour life, dynamically balanced to 25 percent overspeed.
- C. Stator Winding: Two-thirds pitch design to eliminate third harmonic waveform distortion and minimize harmful neutral circulating current when operating in parallel. Provide windings with trickle varnish process. Provide 5 percent rms maximum total voltage output waveform harmonic distortion measured at full load into a load bank.
- D. Rating: Voltage, kW, and kVA as indicated on the drawings, 0.8 power factor, 60 Hz, three-phase, four-pole at 1,800 rpm.
- E. Rating applicable for continuous service in standby power application and in conformance with applicable NEMA standards, latest revision.
- F. Insulation: Minimum Class H.
- G. Temperature Rise: 130 degrees C in 40 degree C ambient as measured by resistance.
- H. Enclosure: Open drip proof.

- I. Voltage Regulation: Include solid-state generator-mounted Volts per hertz exciter-regulator with SCR control to match engine and generator characteristics with output voltage regulation, plus or minus 2 percent, from no load to full load with a maximum of 16 percent instantaneous voltage dip when rated load and power factor are applied with recovery rate of no more than 2 seconds to stable operation. Stable operation is defined as operation with terminal voltage remaining constant within ± 1 percent of rated voltage. Provide built in protection against damage when regulator or generator is run at low frequencies for short periods of time. Include manual controls to adjust voltage drop, plus or minus 5 percent voltage level and voltage gain.
- J. Rotating Brushless Exciter: Incorporate full-wave, three-phase rotating rectifier with hermetically sealed, metallic-type, silicon diodes to supply main field excitation. Provide surge protection to protect against transient conditions.
- K. Telephone Influence Factor (TIF): Maximum 50.
- L. Load Connection Box (Generator Connection Box): Provide end-mounted load connection box for bottom conductor entry. Allow access to power terminals. Provide working clearance in direction of access to connection box.

2.4 ENGINE GENERATOR ACCESSORIES

- A. Exhaust Silencer: Critical-type silencer with muffler companion flanges made of carbon steel with an internal heat blanket and flexible stainless-steel exhaust fitting suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Mount as part of manufacturer's enclosure. Provide stainless steel flexible exhaust adapter for each exhaust outlet between engine and silencer, minimum 24 inches long.
- B. Batteries: Heavy-duty, diesel-starting type, lead-acid storage batteries with minimum capacity per SAE J537 at 0 degrees F, minimum 24 Volts. Provide sufficient capacity for minimum six 10-second starting attempts in specified ambient range. Match battery voltage to starting system. Include necessary cables and clamps.
- C. Battery Tray: Plastic-coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte. Provide with protective Plexiglass cover.
- D. Battery Charger: Constant potential, current-limiting type. Meet battery manufacturer's recommendations for charge rate, float, and equalizing charge potential. Provide low battery voltage alarm contacts for remote annunciation. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 Vac fused input. Provide built-in equalizer charge timer. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.
- E. Line Circuit Breaker: 100 percent rated, Fixed-mounted, Insulated-case circuit breaker on generator output with integral thermal, ground fault and instantaneous solid-state magnetic trip in each pole, sized in accordance with NFPA 70. Include battery voltage-operated shunt trip, connected to open circuit breaker on engine failure. Provide manual charging lever for backup to electric operator. Mount unit in enclosure to meet
- F. NEMA 250, Type 1 requirements. Provide auxiliary contact wired to generator control panel to indicate when generator breaker opens. Provide circuit breaker load side lugs.

- G. Digital Engine-generator Control Panel: NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Isolate generator-mounted control panel from engine vibration. Include provision for padlock and the following equipment and features:
1. Frequency Meter: 45- to 65-Hz range, digital.
 2. Alternating Current (AC)-Output Voltmeter: Digital, 0.5 percent accuracy, with phase selector switch.
 3. AC-Output Ammeter: Digital, 0.5 percent accuracy, with phase selector switch.
 4. Output Voltage Adjustment: Plus, or minus 5 percent range.
 5. LCD Display: Lubrication oil pressure gauge, lubricating oil temperature gauge, cooling water temperature gauge, engine overspeed, engine over crank, fuel oil pressure, low fuel level in tank, high fuel level in tank, low jacket water temperature, approaching high jacket water temperature, approaching low oil pressure, low battery voltage, engine control switch not in auto position, generator breaker open, direct-reading indicating tachometer, and engine running time meter.
 6. Engine start/stop selector switch and emergency stop push button.
 7. Output Contacts: Running status, remote alarm functions, and air intake/exhaust louver control.
- H. Weatherproof Enclosure:
1. Reinforced steel housing, minimum 14 gauge. Allow access to control panel and service points, with lockable doors and panels. Protect against adverse weather and environmental conditions, discourage tampering, and act as barrier to birds, rodents, etc.
 2. Shuttered Air Openings: on front and sides. Cover intake side with mesh screen.
 3. Provide hinged doors on sides and generator end, lockable, keyed the same. Provide extension pipe from crankcase to enclosure exterior with gate valve and plug. Size enclosure to contain batteries and fuel tank. Mount exhaust silencer externally on top of enclosure.
 4. Provide personnel access steps and landings at doors and openings intended to allow walk-in access to generator enclosure interior. Coordinate access step direction and landings with other enclosures, buildings, and structures shown on the plan drawings.
 5. Finish: Electrostatic powder paint process with manufacturer's standard color, heat-resistant engine paint. Exterior enclosure finish minimum 3 mils dry film epoxy chemical-resistant finish, American National Standards Institute (ANSI) 70, light gray.
 6. Enclosure: Served with one 80 -ampere, 480 Volt, three-phase, four-wire service for power requirements for lighting, receptacles, heaters, battery charger, etc. Provide 480 Volt panel with main breaker rated 30,000 AIC, together with necessary transformers and 208Y/120V panel with main breaker rated 10,000 AIC to feed associated equipment. Install wiring to equipment in conduit. Provide bolt-in type circuit breakers.
 7. Provide minimum four industrial LED fixtures with wire guards and wall-mounted toggle switch.
 8. Provide two 20-amp, 120 Vac receptacles inside enclosure for maintenance purposes. Provide 1,920-watt power capacity for each receptacle.
 9. Provide wiring and circuits to engine block heaters, lighting, receptacles, battery charger, and other engine-generator equipment required for complete and operational system.

11. Provide NEMA 4 enclosures for electrical equipment inside generator enclosure, including, but not limited to, junction boxes, pull boxes, control enclosures, power panelboards, enclosed disconnect switches, enclosed circuit breakers, etc.
- I. Remote Engine Annunciator Panel: Include functions listed herein. Ethernet TCP/IO line for communication to engine generator control panel. Surface-mounted panel with standard color painted finish. Annunciators:
 1. Locking type with manual reset button for DC operation from battery bank.
 2. Provide contacts so when shutdown occurs from one set of shutdown contacts, subsequent operation of shutdown contacts is locked off from operating annunciators.
 3. Silence trouble alarm upon operation of silencing switch, but keep pilot illuminated.
 4. On return to normal and resetting of annunciators, sound trouble horn again until switch is returned to normal position.
- J. Terminal Box: Provide single terminal box on engine generator skid for power, control and instrumentation wiring from other components of engine generator system including but not limited to transfer switches. Factory-install and connect to terminal box engine generator skid mounted devices and controls requiring interface. Design and apply separation for power limited cables and wire where required.
- K. Provide load bank circuit breaker with shunt trip to operate when generator is required to provide facility power.
- L. Nameplates: in accordance with Section 26 05 53 Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work and field dimensions are as shown on drawings.
- B. Verify that required utilities are available, in proper location, and ready for use.
- C. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

- A. Install generator system in accordance with manufacturer's instructions.
- B. Provide grounding in accordance with Section 26 05 26 Grounding and Bonding for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Provide full-load test utilizing portable test bank for 4 hours minimum.
- B. Final test conducted in presence of Owner.

1. Interrupt normal source to transfer switch.
 2. Verify switch transfer to emergency source after appropriate time delays and operation of appropriate indicating lights and signal circuits.
 3. After 15 minutes, re-energize normal source.
 4. Verify switch retransfer to normal source after appropriate time delays, engine cool-off time, and operation of appropriate indicating lights and signal circuits.
 5. Demonstrate operation of off/auto/test/engine start control switch.
- C. During test, record the following at 20-minute intervals:
1. Kilowatts.
 2. Amperes.
 3. Voltage.
 4. Coolant temperature.
 5. Ambient temperature.
 6. Frequency.
 7. Oil pressure.
 8. Power factor.
- D. Test alarm and shutdown circuits by simulating conditions.

3.4 MANUFACTURER'S SERVICES

- A. When plant electrical system is essentially complete and plant can be operated, provide full and partial load and operational tests for at least 4 hours, including at least
- B. 2 continuous hours at full-rated load. Include motor starting test to verify specified performance. Perform 50 percent and 100 percent load change. Notify Owner at least
- C. 5 working days prior to beginning of test. Allow Owner to witness tests. Provide required instrumentation and equipment necessary to conduct tests.
- D. Provide factory-qualified erection engineer to personally supervise complete installation of diesel engines and generators, including setting, alignment, assembly, connections, startup, testing, and instruction of Owner. Furnish manufacturer's written certification ensuring that each item of equipment is complete, in good condition, free from damage, and properly installed, connected, and adjusted.
- E. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below, travel time excluded:
1. 1 workdays for installation assistance and inspection of installation.
 2. 1 workdays for functional and performance testing.
 3. 1 workdays for plant startup.
 4. 1 workdays for instruction of site personnel.

3.5 ADJUSTING

- A. Adjust generator output voltage and engine speed.

3.6 CLEANING

- A. Clean engine and generator surfaces. Replace lubricating oil and fuel filters.

3.7 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 32 13-01	Catalog cut-sheets, other descriptive literature		Prior to delivery
26 32 13-02	Layout with dimensions and openings for generator and other components specified. Identify fluid drain ports and clearance requirements		Prior to delivery
26 32 13-03	Weights		Prior to delivery
26 32 13-04	Capacities and ratings		Prior to delivery
26 32 13-05	Mounting, including seismic		Prior to delivery
26 32 13-06	Performance characteristics		Prior to delivery
26 32 13-11	Datasheets		Prior to delivery
26 32 13-14	Electrical voltage, load, and interface		Prior to delivery
26 32 13-15	Wiring and schematic diagrams		Prior to delivery
26 32 13-16	Control interface		Prior to delivery
26 32 13-18	Factory testing results		With record documents
26 32 13-19	Field test results		Prior to delivery
26 32 13-20	Operation and maintenance manuals		With record documents
26 32 13-22	Description of generator transient responses		With record documents
26 32 13-27	Certified statement of rated load compliance at		With operations and maintenance
26 32 13-28	Dimensioned drawings of conduit and cable		Prior to delivery
26 32 13-30	Point-to-point wiring diagrams of field-		Prior to delivery

END OF SECTION

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install automatic transfer switches (ATS).
- B. Abbreviations and Acronyms:
 - 1. American Wire Gauge (AWG).
 - 2. Authority having jurisdiction (AHJ).
 - 3. Automatic transfer switches (ATS).
 - 4. Institute of Electrical and Electronic Engineers, Inc. (IEEE).
 - 5. National Electric Code (NEC).
 - 6. National Fire Protection Association (NFPA).
 - 7. Underwriters Laboratories Inc. (UL).

1.2 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.3 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

- E. ATS Manufacturer:
 - 1. Company specializing in transfer switches and emergency power control systems with 10 years' minimum experience.
 - 2. Maintain local service center capable of emergency service or routine preventative maintenance and offer preventative maintenance contracts. Maintain records of each switch by serial number for 10 years minimum.

1.4 SYSTEM DESCRIPTION

- A. Inherently double-throw power transfer switch unit and control module interconnected to provide complete automatic operation.
- B. Electrically operated and mechanically held. Mechanically interlock to ensure only one of two possible positions preferred source or alternate source.
- C. Provide inspection capability from front. Provide manual operating handle for maintenance, permitting operator to manually stop contacts at any point throughout entire travel, to properly inspect and service contacts.
- D. Provide control module to direct transfer switch operation. Control sensing and logic with built-in microprocessor for reliability, minimum maintenance, and inherent digital communications capability.
- E. Monitor each phase voltage of normal source with 85 to 100 percent adjustable pickup and 70 to 98 percent adjustable dropout, both in increments of 1 percent, fully field adjustable without use of tools, meters, or power supplies. Factory set to pick up at
- F. 90 percent drop out at 85 percent.
- G. Provide alternate source voltage sensing with 85 to 100 percent adjustable pickup and 84 to 86 percent fixed dropout and frequency sensing with 90 to 100 percent adjustable pickup and 87 to 89 percent fixed dropout, fully field adjustable in 1 percent increments without use of tools, meters, or power supplies. Factory set to pick up at 90 percent voltage and 95 percent frequency.
- H. Control Module: Include time delays fully field adjustable in increments over entire range as follows:
 - 1. Time delay adjustable from 0 to 6 seconds and factory set at 1 second to override momentary preferred source outages to delay transfer switch and engine starting signals.
 - 2. Transfer to alternate source time delay adjustable from zero to 5 minutes.
 - 3. Retransfer to preferred source time delay, automatically bypassed if alternate source fails and preferred source is acceptable, adjustable from zero to
 - 4. 30 minutes.
 - 5. Unloaded running time delay for standby engine generator cooldown, adjustable from zero to 60 minutes.
- I. Start Signal: Prevent dry cranking of generator by requiring generator to reach proper output and to run for cooldown duration setting, regardless of whether preferred source restores before load is transferred.

PART 2 PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. ASCO 7000.
- B. Russelectric, Type RMT.
- C. Cummins/ONAN.
- D. Zenith Controls Inc.

2.2 AUTOMATIC TRANSFER SWITCHES (ATS)

- A. Provide one low-voltage automatic transfer switch (ATS) capable of switching resistive and inductive-type loads and providing control as to which source serves these loads.
- B. Nominal Voltage and Poles:
 - 1. 480Y/277 Volts, three-phase, four-wire, plus ground.
 - 2. Four-pole on common shaft (three-phase, plus neutral).
- C. Short-circuit Withstand Capability:

Switch Amperes	3-Cycle Closing and Withstand Rating, ATS Used with Molded- Case Breaker, rms Symmetrical Amps
100 to 400	42,000
600 to 800	65,000
1,000 to 1,200	85,000
1,600-4000	100,000

- D. Continuous Current Rating: As indicated on the drawings.
- E. Transfer Mechanism:
 - 1. Single momentarily energized electric operator to activate double-throw switch.
 - 2. Overcenter-type linkage to provide quick-make, quick-break action of switch contacts.
 - 3. Capable of operating at 70 percent of nominal system voltage.
 - 4. Interlock preferred and alternate source contacts mechanically and electrically to prevent simultaneous closing.
 - 5. Silver-tungsten alloy main contacts mechanically held without use of hooks, latches, magnets, or springs.
 - 6. Separate arcing contacts and arc extinguishing chutes.

- F. Manual Operator: Capable of actuating switch with same action and speed as electric operator.
- G. Enclosure:
 - 1. NEMA 1.
 - 2. Finish: Manufacturer's standard color.
 - 3. Door lock with provisions for padlocking.
- H. Lugs:
 - 1. Two-hole, long barrel copper only compression lugs.

2.3 ATS ACCESSORIES

- A. Provide one each Form C contact rated 5A at 120 Vac for each of the following:
 - 1. Loss of preferred voltage via voltage sensing relay on preferred source for generator start signal.
 - 2. Loss of preferred voltage via voltage sensing relay on preferred source for facility monitoring use.
 - 3. Alternate source detected at line side of transfer switch via voltage-sensing relay on preferred source.
 - 4. Transfer switch in preferred position.
 - 5. Transfer switch in alternate position.
- B. Provide one red and one green indicating light on enclosure door.
 - 1. Illuminate green light when switch is in preferred position.
 - 2. Illuminate red light when switch is in alternate position.
- C. Provide two amber indicating lights on enclosure door.
 - 1. Illuminate one light when preferred source is present.
 - 2. Illuminate second light when alternate source is present.
 - 3. Operate lights from voltage-sensing relays, not directly from main busses.
- D. Identify control wire terminations with tubular sleeve-type markers.
- E. Provide schematic drawing under clear plastic on interior of enclosure door.
- F. Communication Network: Full-duplex RS 422 interface built into ATS control module to enable digital communications with remotely located annunciators and/or network supervisors. Enable remote annunciator to indicate and control the following functions via digital communications in control panel:
 - 1. Indication:
 - a. Load connected to preferred or alternate source.
 - b. Preferred and/or alternate source available.
 - c. Transfer switch in test mode.
 - d. Transfer switch control panel in time-delay function.
 - 2. Control:
 - a. Simulate preferred source failure to sensing controls.
- G. Exerciser Clock:
 - 1. Sets day, time, and duration of exercise period.

- 2. Provide with/without load selector switch
- H. Manual/automatic retransfer selector switch.
- I. Battery Charger:
 - 1. SCR voltage regulated type with float and taper features.
 - 2. 6 amps at 24 Vdc with charging ammeter.
- J. Elevator Signal Relay: 1- to 300-second adjustable pre-signal prior to transfer and retransfer and signal when transfer switch is in emergency position.
 - 1. Terminations: Provide hardware as required to accommodate connector types specified in Section 26 05 19 Low-voltage Electrical Power Conductors and Cables.
- K. Nameplates: Provide nameplates in accordance with Section 26 05 53 Identification for Electrical Systems.

2.4 ATS CONTROL DEVICES

- A. Four-position switch mounted on enclosure door with four modes as follows:
 - 1. Off:
 - a. Control relays de-energized, engine-start circuit open. No operation under any circumstance.
 - b. Provide white, door-mounted indicating light illuminated when in off position.
 - 2. Auto: Complete automatic operation as specified.
 - 3. Test: Simulate failure of preferred source. Transfer to alternate as specified. Retransfer to preferred after switch is returned to auto position after appropriate time delay. Provide momentary contact switch to override time delay from alternate to preferred.
 - 4. Engine Start: ATS remains connected to preferred source and initiates engine- start circuit. Transfer to alternate source only on failure of preferred source and after appropriate time delay.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ATS in accordance with Manufacturer's instructions.

3.2 ADJUSTING AND CLEANING

- A. Adjust contactors, time delays, and functioning parts.
- B. Clean exterior and interior surfaces.

3.3 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below, travel time excluded:
1. 1 workday for installation assistance and inspection of installation.
 2. 1 workday for functional and performance testing.
 3. 1 workday plant startup.
 4. 1 workday for instruction of site personnel.

3.4 FIELD QUALITY CONTROL

- A. Test ATS in accordance with manufacturer's instructions.
- B. Test in accordance with requirements of authority having jurisdiction.

3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 36 23-02	Catalog cutsheets, other descriptive literature		Prior to delivery
226 36 23-03	Layout with dimensions and openings		Prior to delivery
26 36 23-05	Capacities and ratings		Prior to delivery
26 36 23-07	Performance characteristics		Prior to delivery
26 36 23-11	Datasheets		Prior to delivery
26 36 23-13	Electrical voltage, load, and interface for accessories		Prior to delivery
26 36 23-14	Wiring and schematic diagrams		Prior to delivery
26 36 23-15	Control interface		Prior to delivery
26 36 23-17	Field test results	[X]	[Prior to delivery] [Per construction schedule] [With record documents] [With operations and maintenance manuals] [Before date of Substantial Completion] [Other]
26 36 23-18	Operation and maintenance manuals		With operations and maintenance manuals
26 36 23-19	Training		Before date of Substantial Completion

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 36 23-21	Manufacturer's specifications		Prior to delivery
26 36 23-23	Installation instructions		Prior to delivery

END OF SECTION

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SECTION 26 41 00

FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary for the new Laboratory and Maintenance Building only to furnish and install:
 - 1. System design.
 - 2. Air terminals, interconnecting conductors, and other system components and accessories.
 - 3. Grounding and bonding for lightning protection.
 - 4. System inspection and certification.

1.2 SYSTEM DESCRIPTION

- A. Lightning Protection System: National Fire Protection Association (NFPA) 780; Class I Underwriters Laboratories Inc. (UL) 96A; master labeled system protecting roof-mounted mechanical equipment, consisting of air terminals on roofs, bonding of structure and other metal objects, grounding electrodes, and interconnecting conductors.

1.3 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Authority having jurisdiction (AHJ)
 - 2. Independent Protection Co. (IPC)
 - 3. Lightning Protection Institute (LPI)
 - 4. National Electric Code (NEC)
 - 5. National Fire Protection Association (NFPA)
 - 6. Underwriters Laboratories Inc. (UL)

1.4 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.5 QUALITY ASSURANCE

- A. Provide the Work in accordance with NFPA 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.

- B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

1.6 QUALIFICATIONS

- A. Designer: Lightning Protection Institute (LPI)-certified Designer or recognized lightning protection Manufacturer.
- B. Manufacturer: Company specializing in lightning protection equipment with minimum 3 years' documented experience and member of LPI.
- C. Installer: Authorized installer of manufacturer with minimum 3 years' documented experience and member of LPI.
- D. Inspection of Final Installation and Grounding Connections of the System: Performed by LPI-certified inspector.

1.7 COORDINATION

- A. Coordinate work of this Section with roofing and exterior, and interior finish installations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Thompson Lightning Protection.
- B. Independent Protection Co. (IPC).
- C. Erico.
- D. Kuefler Lightning Protection.
- E. Advanced Lightning Technology, LTD.

2.2 MATERIALS

- A. Components: Aluminum unless otherwise specified.
 - 1. Air Terminals:
- B. Solid aluminum with tapered points.
 - 1. Length sufficient to extend minimum 10 inches above object being protected.
 - 2. Diameter: 1/2 inch.

- C. Ground Rods:
 - 1. Materials: Copper clad steel.
 - 2. Diameter: 5/8 inch.
 - 3. Length: 10 feet.
- D. Conductors: Aluminum Cable.
- E. Cable Connections and Splicers:
 - 1. Welds: Exothermic process.
 - 2. Fasteners: Bolted, clamp type.
 - 3. Through-Roof: Lead seal flashing washer.
- F. Conduit: PVC Schedule 40 per Section 26 05 33 Raceway and Boxes for Electrical Systems. PVC conduit shall not be installed in exposed areas.
- G. Contact the Owner at least 7 days before inspections and tests are scheduled.

PART 3 PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify surfaces are ready to receive work.
- B. Verify field measurements as shown on shop drawings.
- C. Beginning of installation means installer accepts existing conditions.

3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this Section from damage or disfiguration.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Certify completed system as UL master labeled.
- C. Install ground rods per Section 26 05 26 Grounding and Bonding for Electrical Systems.

3.4 FIELD QUALITY CONTROL

- A. Isolate lightning protection system from other ground conditions while performing tests.
- B. Obtain services of Underwriters Laboratories Inc. to provide inspection and certification of lightning protection system.
- C. Obtain UL master label and attach to building at location directed by Owner.

3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 41 00-01	Resumes of key Contractor personnel for design-build	X	Prior to delivery
26 41 00-02	Catalog cutsheets, other descriptive literature showing dimensions and materials of each component, include indication of certification by listing authority		Prior to delivery
26 41 00-03	Layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects		Prior to delivery
26 41 00-04	Detail of terminal, electrode, and conductor sizes, and connection and termination details.		Prior to delivery
26 41 00-05	Field test results (include description of equipment tested, description of test, test results, conclusions, recommendations, and signature of responsible test organization authority)		Before date of Substantial Completion

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
 - 1. Lighting materials.
 - 2. Lenses/louvers.
 - 3. Reflectors.
 - 4. Listings.
 - 5. Lamps.
 - 6. Ballasts.
 - 7. LED emergency lighting units.
 - 8. Self-contained emergency power exit signs.
 - 9. Site lighting poles.

- B. Related Sections:

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating current (AC)
 - 2. American Wire Gauge (AWG)
 - 3. Authority having jurisdiction (AHJ)
 - 4. Electrical Testing Lab (ETL)
 - 5. Illumination Engineering Society of North America (IESNA)
 - 6. Light Emitting Diode (LED)
 - 7. National Electric Code (NEC)
 - 8. National Fire Protection Association (NFPA)
 - 9. Personal computer (PC)
 - 10. Toxicity Characteristic Leaching Procedure (TCLP)
 - 11. Underwriters Laboratories Inc. (UL)
 - 12. United States Department of Agriculture (USDA)
 - 13. United States Environmental Protection Agency (EPA)
 - 14. United States Food and Drug Administration (FDA)

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.4 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), Canadian Electric Code (CEC), Canadian Standards Association (CSA), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- E. Standard Products:
 - 1. Provide materials and equipment of manufacturers regularly engaged in the production of products specified in this section and that are of equal material, design, and workmanship.
 - 2. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to Bid opening in similar applications under similar circumstances and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
 - 3. Material and Equipment Manufacturing Date: Do not use products manufactured more than 3 years prior to date of delivery to Site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship luminaires with parabolic-type louvers protected by a clear plastic bag. Handle with white gloves to prevent fingerprint damage.
 - 1. Ship poles with bolt circle template, base cover, handhold cover, and shaft cap or tenon.
- B. Aluminum Poles
 - 1. Provide manufacturer's standard protection for the finish during shipment and installation. At minimum.
 - 2. Provide manufacturer's standard protection for the finish during shipment and installation. At minimum, spirally wrap each pole shaft with protective paper secured with tape, and ship small parts in boxes.
 - 3. Do not store poles on ground.
 - 4. Support poles so they are at least 1 foot above ground level and growing vegetation.
 - 5. Do not remove factory applied pole wrappings, until just before installing pole.
 - 6. Ship poles with bolt circle template, base cover, handhold cover and shaft cap or tenon.

PART 2 - PRODUCTS

2.1 LIGHTING MATERIALS

- A. Provide minimum quality products as described in the luminaire schedule.
- B. Provide luminaires rated by manufacturer to start and operate to their full lumen capacity for rated life of the luminaire at the minimum low and maximum high ambient temperatures as defined in the Contract Documents at their installation location.
- C. Recessed Luminaires: Provide feed-through junction boxes. Access components through the ceiling opening.
- D. Luminaires Provide with minimum 18-American Wire Gauge (AWG) wiring leads.
- E. Component Access: Accessible and replaceable without removing luminaire from ceiling.

2.2 UL / ELECTRICAL TESTING LAB (ETL) LISTINGS

- A. Luminaires and Components: UL- or ETL-tested, listed, and labeled.
- B. Provide luminaires installed under canopies, roofs, or similar damp or wet locations with UL/ETL listing and labeling as suitable for damp or wet locations.
- C. Thermally protect for this application recessed luminaires installed in fire-rated ceilings and using a fire-rated protective cover and provide a fire-rated listing.
- D. Provide luminaires in exterior installations with a UL/ETL listing and labeling as suitable for wet locations.

2.3 ILLUMINATION ENGINEERING SOCIETY OF NORTH AMERICAN (IESNA) PHOTOMETRICS

- A. Provide luminaires with IESNA formatted photometric files via an ETL for lighting software interface.

2.4 LAMPS

- A. Acceptable Manufacturers:
 - 1. General Electric.
 - 2. Osram/Sylvania.
 - 3. Phillips.
 - 4. Venture.
 - 5. Nichia
 - 6. Cree
- B. Light Emitting Diode (LED) Lamps
 - 1. Comply with Restriction of the use of Certain Hazardous Substances (RoHS).
 - 2. Correlated Color Temperature (CCT) as scheduled.
 - 3. Provide lamp capable of line voltage dimming. Verify product is compatible with dimming equipment.

2.5 LED SOURCE SYSTEMS

- A. General:
 - 1. Provide IESNA LM-80 and LM-79 Test reports.
 - 2. Warranty: 5 years minimum.
- B. Electronic Module/Light Engine:
 - 1. Mount all components to a single plate and factory prewired with quick disconnect plugs.
 - 2. Include a driver, thermal control device, thermal protector device, and surge protector device in accordance with IEEE/ANSI C62.41.2 to Category C Low.
 - 3. Light Engine Rating per TM-21 60,000 at 65 degrees C L84.
 - 4. Correlated Color Temperature (CCT). As indicated on the Luminaire Schedule
 - 5. Color Rendering Index (CRI): Minimum of 80
- C. Drivers:
 - 1. Expected life of 50,000 hours minimum.
 - 2. Operating Voltage Range: 50/60-Hz input source as indicated with sustained variations of plus or minus 10 percent voltage with no damage to driver.
 - 3. Input current total harmonic distortion: less than 20 percent up to 50 percent of full load rating.
 - 4. Power Factor: Greater than 0.90.
 - 5. Dimming:
 - a. Continuously dimmable from 10 to 100 percent.
 - b. Dimming Control 0 10V.

2.6 SELF-CONTAINED EMERGENCY POWER EXIT SIGNS

- A. Acceptable Manufacturers:
 - 1. Lithonia.
 - 2. Sure-Lights.
- B. Type: Exit signs as described above, except with integral battery-operated emergency power supply, including power failure relay, test switch, ac on pilot light, battery, and fully automatic two-rate charger.
- C. Battery: Nickel-cadmium cell requiring no maintenance or replacement for 10 years under normal conditions.

2.7 EMERGENCY DRIVER/BALLAST

- A. Acceptable Manufacturers:
 - 1. Bodine.
 - 2. Siltron.
- B. For use in standard LED luminaires designated for emergency lighting service.
- C. Unit: Self-contained with automatic transfer to battery supply on power failure, including test switch, alternating current (AC) on pilot light, fully automatic two-rate charger, battery, and power supply capable of operating LED luminaire with a minimum output of 1400 lumens for a minimum of 90 minutes.

- D. Battery: Sealed high-temperature, nickel-cadmium cell requiring no maintenance or replacement for 10 years under normal conditions.
- E. Provide access hatches, for emergency backup ballasts, adjacent to recessed 6 inch or less diameter down lights installed in inaccessible ceilings.

2.8 SITE LIGHTING POLES

- A. General:
 - 1. Site Lighting Poles: Meet EPA wind loading rating requirements.
 - 2. Refer to pole base details as shown on the drawings for specific pole base requirements.
 - 3. Pole Top: Provide 2-3/8-inch outside diameter slip fitter.
 - 4. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.
 - 5. Hand Hole: 3-inches by 5-inches with removable weatherproof cover installed 18-inches above bottom of pole. Provide matching gasketed cover plate.
- B. Aluminum Poles:
 - 1. Manufactured of corrosion-resistant aluminum alloys. Seamless extruded or spun seamless type with minimum 0.188-inch wall thickness.
 - 2. Shape: Round Straight.
 - 3. Provide pole grounding connection designed to prevent electrolysis when used with copper ground wire.
 - 4. Shaft Top: Fitted with cap.
 - 5. Base:
 - a. Anchor bolt mounted and machined to receive lower end of shaft.
 - b. Welded joint between shaft and base.
 - c. Base Cover: Cast aluminum alloy.
 - d. Hardware, Except Anchor Bolts: either anodized aluminum alloy or stainless steel.
 - e. Handhole.
 - 6. Provide pole cast-in-place foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end.
 - 7. Provide base covers to match pole and galvanized nuts and washers for anchor bolts.
 - 8. Pole and Bracket Finish: Uniform satin finish to match fixture.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify ceiling types and coordinate with luminaires and accessories.
- B. Furnish and install lamps in luminaires and lamp holders.
- C. Fit recessed luminaire trims snugly to the mounting surface without light leaks or gaps. Provide heat-resistant rubber gasketing where necessary.

- D. Separately support from structure luminaires installed in lay-in ceilings from two opposite corners and fasten to grid. Reference Section 26 05 29 Hangers and Supports for Electrical Systems.
- E. Install luminaires as shown on drawings; install aligned, aimed, and leveled. Coordinate aiming of adjustable luminaires with Engineer prior to completion of project.
- F. Emergency Battery-Pack Luminaires: Provide relay to automatically transfer unit from normal power to battery supply upon loss of normal power and back to normal standby state 0 minutes to 10 minutes (adjustable) after return to normal power.
- G. Mark standard luminaires equipped with emergency power with a red adhesive sticker (not more than 3/8 inch in diameter) mounted on metal door frame.
- H. Provide in-line fusing at pole hand hole for pole-mounted luminaires. Reference Section 26 05 05 Basic Electrical Materials and Methods.
- I. Provide removable unitized component tray with separable connector in pole-mounted luminaires.
- J. Handle parabolic trim cones and louvers with new, clean white cotton or silk gloves. Deliver trims in clean, sound condition at completion of project.
- K. Leave luminaires clean at time of acceptance of work with lamps operational. Relamp inoperable lamps at completion of work
- L. Support swinging-type luminaires with a separate safety cable to structure capable of supporting four times the vertical load.
- M. Install underground wiring in conduit with watertight connections. Refer to Section 26 05 33 Raceway and Boxes for Electrical Systems.
- N. Luminaire Pole Bases: Size and construct as indicated on drawings. Project anchor bolts 2 inches minimum above base. Install poles on bases plumb; provide shims and double nuts for adjustment. Grout around pole base.
- O. Embedded Luminaire Poles: Depth as recommended by pole manufacturer; install plumb.
- P. Use belt slings or non-chafing ropes to raise and set prefinished luminaire poles.
- Q. Where a ground wire is indicated, connect ground wire to pole and luminaire ground; otherwise, provide a ground rod at each pole with grounding conductors.
- R. Coordinate lighting controls with Section 26 09 23 for Lighting Control Devices.

3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 50 00-01	Luminaires: Complete ITL photometric test data for each luminaire formatted in ".ies" format, including candlepower distribution curves in two or more planes, candlepower chart zero to 180 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations. For outdoor luminaires include BUG rating and IES distribution designation.		Prior to delivery
26 50 00-02	Luminaire: Complete specification including metal gauge, dimensions, lens material, and accessory information.		Prior to delivery
26 50 00-05	LED Luminaires: Catalog cut sheets including IESNA LM-80 test reports, IESNA TM-21 ratings, operating temperature range, warranty, rated life, surge protection, thermal control device, correlated color temperature, and color rendering index.		Prior to delivery
26 50 00-06	Site lighting pole data and catalog cuts, including wind loading, complete dimensions, material weight, and finish.		Prior to delivery
26 50 00-08	Equipment operation and maintenance manuals.		With operations and maintenance manuals

END OF SECTION

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SECTION 26 52 13

EMERGENCY LIGHTING POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install emergency lighting power supplies.

1.2 SYSTEM DESCRIPTION

- A. System Configuration: Forward transfer-type emergency power supply consisting of rectifier/charger unit, storage battery, and solid-state inverter with static transfer switch in one or several enclosures.
- B. Operating Sequence: When utility power is available, supply load through transfer switch and maintain battery charge via battery charger. If utility fails, transfer load to battery-powered inverter. When utility is restored, retransfer load and restore battery charge via battery charger.

1.3 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. Alternating current (AC).
 - 2. Authority having jurisdiction (AHJ).
 - 3. Automatic Transfer Switches (ATS).
 - 4. Light Emitting Diode (LED).
 - 5. National Electric Code (NEC).
 - 6. National Fire Protection Association (NFPA).
 - 7. Total Harmonic Distortion (THD).
 - 8. Underwriters Laboratories Inc. (UL).

1.4 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.5 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally

recognized testing laboratory or other organization acceptable to the AHJ, to provide a basis for approval under the above listed agency.

- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Powerware.
- B. Dual-Lite.
- C. Lithonia (EM Div.).
- D. Siltron.
- E. Lightguard .

2.2 EMERGENCY POWER SUPPLY

- A. Input Voltage: 480 Volts, 60 Hz, three-phase.
- B. Output Power: As shown on the drawings.
- C. Battery Operating Time: 1.5 hours at full load with a discharge to not less than
- D. 87.5 percent of nominal battery voltage.
- E. Output Voltage: 480Y/277 Volts, plus or minus 5 percent.
- F. Inverter:
 - 1. Solid-state construction.
 - 2. True sine wave output suitable for computer applications.
 - 3. Suitably protected from short circuits and overloads.
 - 4. Output Frequency: 60 Hz, plus or minus 0.5 Hz.
 - 5. Suitable for use with electronic ballasts.
- G. Efficiency: 90 percent minimum.
- H. Total Harmonic Distortion (THD): Less than 10 percent at fully resistive load.
- I. Transfer Switch: Static type.

- J. Battery: Lead antimony (lead acid), sealed type. Provide barrier around battery terminals to prevent accidental contact.
- K. Battery Life: 10 Year.
- L. Accessories:
 - 1. Provisions for remote battery alarm.
 - 2. Output voltmeter.
 - 3. Output ammeter.
 - 4. Test switch to simulate power failure.
 - 5. Battery charge indicator.
 - 6. Battery ammeter.
 - 7. Maintenance required alarm indicator.
 - 8. RS232 communication system.
 - 9. Output circuit breaker.
 - 10. Output trip alarm.
 - 11. Remote meter pane.
 - 12. Maintenance bypass switch
 - 13. Form "C" contacts.
 - 14. External modem for RS232.
- M. Light Emitting Diode (LED)-type Indicating Lamps:
 - 1. Normal alternating current (AC) on.
 - 2. High charge.
 - 3. Charging.
 - 4. Electrolyte level alarm.
- N. Charger: Solid-state SCR type; dual rate; designed to maintain battery in full-charge condition during normal conditions; capable of fully recharging batteries from
- O. 87.5 percent of nominal battery voltage within 24 hours following a discharge. Provide short-circuit protection on output of charger.
- P. Exercising Time Clock: Simulate input power interruption for adjustable 0- to 15-minute duration every 30 days.
- Q. Rated Output: 90 minute.

2.3 REMOTE TROUBLE MONITOR

- A. Indicators: Common trouble lamp and audible tone. Include silence switch arranged for ringback feature.
- B. Enclosure:
 - 1. Freestanding with manufacturer's standard finish.
 - 2. Where two or more enclosures are used, provide enclosures of the same dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units plumb and level.
- B. Provide interconnection between cabinets.

3.2 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below (travel time excluded):
 - 1. 1 workday for installation assistance and inspection of installation.
 - 2. 1 workday for functional and performance testing.
 - 3. 1 workday for plant startup.
 - 4. 1 workday for instruction of site personnel.

3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 52 13-01	Heat rejection and airflow requirements. Dimensional and Weight Information		Prior to delivery
26 52 13-02	Data on batteries.		Prior to delivery
26 52 13-03	Interconnection diagram for external wiring.		Prior to delivery
26 52 13-04	Operation and maintenance manual.		Prior to delivery

END OF SECTION

SECTION 27 00 10

GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements specifically applicable to Division 27 Communications requirements.
- B. The Contractor is responsible for:
 - 1. Furnishing materials, labor, and equipment in accordance with these Specifications and the accompanying drawings.
 - 2. Complete systems in accordance with the intent of these contract documents.
 - 3. Coordinating the details of facility equipment and construction for other specification divisions that affect the communications system work covered under this division.
 - 4. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
- C. Intent of Drawings: Communication plan drawings show only general locations of raceways, cable tray, equipment, and devices, unless specifically dimensioned.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. American National Standards Institute (ANSI)
 - 2. Authority having jurisdiction (AHJ)
 - 3. Building communications room (BCR)
 - 4. Electrical Equipment Manufacturers Association of Canada (EEMAC)
 - 5. Electronics Industry Association (EIA)
 - 6. Fiber Optic Distribution Unit (FDU)
 - 7. Horizontal cross connect (HC)
 - 8. Horizontal distribution terminal (HDT)
 - 9. Institute of Electrical and Electronic Engineers, Inc. (IEEE)
 - 10. Local area network (LAN)
 - 11. Main communications room (MCR)
 - 12. National Electric Code (NEC)
 - 13. National Fire Protection Association (NFPA)
 - 14. Satellite communications cabinet (SCC)
 - 15. Satellite communications room (SCR)
 - 16. Telecommunications outlet (TO)
 - 17. Telecommunications Industry Association (TIA)
 - 18. Telecommunication room (TR)
 - 19. Underwriters Laboratories Inc. (UL)
 - 20. Unshielded twisted pair (UTP)

21. Wide area network (WAN)

B. Definitions:

1. Active Equipment: Electronic equipment used to develop various wide area network (WAN), local area network (LAN) services, and telephony services (e.g., digital multiplexers, RS 232 controllers, Ethernet wiring hubs, PBX switches).
2. Backbone Media: The portion of the communications wiring system that interconnects communications rooms and entrance facilities; includes cabling and mechanical termination at the cross connects.
3. Backbone Pathways: Raceway, sleeves, cable tray, and other facilities used for the installation of backbone media.
4. Building Communications Room (BCR): Room in each building used to distribute communications services to satellite communications rooms (SCRs),
5. satellite communications cabinets (SCCs), and telecommunication rooms (TRs) in the same building and interconnect with the main communications room (MCR). Typically, the BCR contains passive equipment used for electrical protection (protectors) and building cross connect. The BCR may also include active equipment used for LAN and serve the functions of an SCR.
6. Campus: Buildings and grounds of a multibuilding complex (e.g., university, industrial park, or military establishment).
7. Channel: The end-to-end transmission path between two points at which application-specific equipment is connected; may include one or more links, cross connect jumpers and/or patch cords, and work area station cords, but does not include connection to active equipment.
8. Communications Rooms: Collective term used to describe MCRs, BCRs, SCRs, SCCs, and TRs.
9. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into outlet pathways.
10. Cross Connect: Group of wall or rack-mounted connection points (e.g., wiring blocks or fiber optic distribution units (FDUs) used to terminate and administer building cabling).
11. Cross Connections: Jumpers and/or patch cords to join communications circuits at the cross connect.
12. Fiber Optic Distribution Unit (FDU): Wall- or rack-mounted cross-connect used to terminate and administer fiber optic cabling. Also known as optical fiber cross connect.
13. Horizontal Cross Connect (HC): A cross-connect of horizontal cabling to other cabling.
14. Horizontal Distribution Terminal (HDT): Wiring block housed in a hinged cover enclosure which provides a transition connection between unshielded twisted pair (UTP) cables running to the serving communication room and UTP cables running to telecommunications outlets (TOs) in the work area.
15. Horizontal Media: Portion of the communications wiring system that extends from SCRs, SCCs, or TCs to the TO at the work area; includes cabling, TOs, and mechanical cable termination at the cross connect and the TO.
16. Horizontal Pathways: Raceway, cable tray, access floors, and underfloor facilities used for the installation of horizontal media.

17. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits (e.g., eight-position/eight-contact modular jacks).
18. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
19. Local Area Network (LAN): Data transmission facilities connecting a number of communicating devices (e.g., serial data, Ethernet, token ring, FDDI). Typically, the network is limited to a single premise.
20. Main Communications Room (MCR): Room used to distribute communications services to BCRs on the campus and to interconnect campus services with the local exchange companies. Typically, the MCR contains passive equipment used for electrical protection (protectors) and main campus cross connect. The MCR also includes active equipment used for PBX, WAN, and LAN.
21. Optical Fiber Cross Connect: See FDU.
22. Passive Equipment: Nonelectronic hardware and apparatus (e.g., equipment racks, cable trays, electrical protection, wiring blocks, FDUs).
23. Patch Cords: Length of copper or fiber cable with connectors at each end used to join communications circuits at a cross connect.
24. Pathways: Raceway, sleeves, cable tray, access floors, underfloor systems, and other facilities used for the installation of communications media.
25. Protectors: Electrical protective devices used to protect against hazards, such as contact with electrical circuits, lightning, and above-normal voltages induced by high currents on power circuits in proximity to a metallic communications circuit.
26. Raceways: Enclosed channel designed expressly for holding wires and cables (e.g., conduit, surface raceways, and wireways).
27. Satellite Communications Cabinet (SCC): Cabinet or group of cabinets which may serve the same purpose as an SCR.
28. Satellite Communications Room (SCR): Room used to distribute communications services to work areas and to interconnect with the BCR. The SCR contains passive equipment used for cross connect and also includes active network equipment used for LANs.
29. Telecommunication Room (TR): An enclosed space which contains passive equipment used for telephone cross connects between the backbone and horizontal cabling.
30. Telecommunications Outlet (TO): Connecting device, consisting of a faceplate with jacks, mounted in a work area to interconnect horizontal cabling with station equipment.
31. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.
32. Wiring Block: Punch down terminating equipment used to terminate twisted-pair cross-connect facilities.
33. Work Area: A building space where users interact with communications terminal equipment.

C. References Standards:

1. Materials, equipment, and methods are to conform to the requirements of the following communications standards:
 - a. American National Standards Institute (ANSI) / Electronics Industry Association (EIA) / Telecommunications Industry Association

- b. (TIA) 568-B-2001, Commercial Building Telecommunications Cabling Standard.
- c. ANSI / EIA / TIA 569-A-1998, Commercial Building Standard for Telecommunications Pathways and Spaces.
- d. Institute of Electrical and Electronic Engineers, Inc. (IEEE) 802.3, Standard for Ethernet Connection through Coaxial, Twisted-pair, and Fiber Media.
- e. National Electrical Code (NEC) Article 725, Signal Circuits.
- f. NEC Article 770, Optical Fiber Cables.
- g. NEC Article 800, Communication Circuits.
- h. Standards related to or referenced by the standards listed above.

1.3 SYSTEM DESCRIPTION

- A. The communications distribution system consists of six major subsystems:
 - 1. Backbone Pathways: Interbuilding and intrabuilding facilities, such as raceways and cable tray, used by the backbone communications distribution subsystem, to interconnect common carrier service providers and communications rooms.
 - 2. Horizontal Pathways: Intrabuilding facilities such as raceways and cable tray used by the horizontal communications distribution subsystem to connect SCRs, SCCs, TRs, and CPs with TOs located at the work area.
 - 3. Communications Room Distribution Subsystem: MCR, BCR, SCR, SCC, and TC passive equipment installations used to distribute communications services.
 - 4. Backbone Communications Distribution Subsystem: Interbuilding and intrabuilding backbone transmission media and cable terminations.
 - 5. Horizontal Communications Distribution Subsystem: Intrabuilding horizontal transmission media, TOs, and cable terminations. Used by the horizontal communications distribution subsystem to connect SCRs, SCCs, TRs, and CPs with TOs located at the work area.
 - 6. Work Area Communications Distribution Subsystem: Special-use telephones and components used to interconnect TOs and station equipment.

1.4 DESIGN CRITERIA

- A. The following are incorporated into the design:
 - 1. The communications equipment room installations are designed to be as similar as possible.
 - 2. Electrical protection is provided for underground and outdoor copper cabling.
 - 3. The zoning of BCRs, SCRs, SCCs, and TCs is intended to restrict the maximum physical horizontal wiring length between cross connects and a served TO 295 feet.
- B. Compliance by the Contractor with the provisions of this specification does not relieve them of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.

- C. Electrical components and systems manufactured within the scope of Underwriters Laboratories Inc. (UL) to conform to the UL standards, and be UL-listed and labeled with an applied UL listing mark.
- D. Corrosive areas are designated on the drawings. Raceways, elbows, fittings, couplings, junction boxes, and pull boxes to be of materials specified hereafter. NEMA 4X (or Electrical Equipment Manufacturers Association of Canada (EEMAC) as applicable) enclosures to be used for all electrical equipment and devices. Other devices and materials to be labeled as suitable for installation in a corrosive environment.
- E. Hazardous areas are designated on the drawings. Provide devices, materials, and equipment for installation in hazardous areas that are specifically approved for installation in hazardous areas of class, division, and group indicated and are of construction that will ensure safe performance under conditions of proper use and maintenance.
- F. Material and equipment must be listed and labeled for its intended purpose, environment, or application. Validate when used in extreme climate areas.

1.5 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3 for a list of submittal requirements for this Section.

1.6 QUALITY ASSURANCE

- A. Provide the Work in accordance with National Fire Protection Association (NFPA) 70 (National Electric Code - NEC), Canadian Electric Code (CEC), Canadian Standards Association (CSA), as applicable. Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.

1.7 QUALIFICATIONS

- A. The Contractor is to have a minimum of 3 years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the types of media or system component specified in the contract documents (e.g., Category 5e UTP, Category 6 UTP, multimode fiber, single-mode fiber). In the case of newer technologies that do not have a 3-year history, the Contractor is to have documented experience for at least half of the lifetime of the new technology.

- B. Additional WAN and LAN Qualifications: Minimum of 6 years' successful business experience in design and installation of systems like the type specified.
- C. Category 5e and 6 UTP and Fiber Optic Cable Technicians: Documented training and/or certification for the types of media and connectors specified.
- D. Project Manager, Engineers, Supervisors, and Principal Skilled Technicians: Minimum 6 depending on the projects size and complexity years' experience in like work.

1.8 REGULATORY REQUIREMENTS

- A. Conformance to the latest codes and other legal requirements is the responsibility of the Contractor.
- B. Obtain permits and arrange inspections required by codes applicable to this Section and submit written evidence to Owner that the required permits, inspections, and code requirements have been secured.
- C. Communications cables are to conform to NEC Article 725, Signal Circuits and NEC Article 800, Communication Circuits as applicable.
- D. Fiber optic communications cables are to conform to NEC Article 770, Optical Fiber Cables.

1.9 COORDINATION

- A. Coordinate location of equipment specified in this Section with other trades to avoid interference with work of other trades.

PART 2 PART 2 PRODUCTS

2.1 GENERAL

- A. Provided materials and equipment are to be labeled and/or listed as acceptable to the AHJ as suitable for the use intended.
- B. Provide manufacturer's standard finish color, except where specific color is indicated.

PART 3 PART 3 EXECUTION

3.1 WORKMANSHIP

- A. Install system components under the direction of qualified personnel so appearance and workmanship meets or exceeds industry standards.
- B. Install and test cable, material, and equipment in accordance with manufacturers' instructions.

- C. Coordinate work with equipment suppliers and other contractors.

3.2 SERVICE CONTINUITY

- A. Continuous operation of the Owner's existing systems and public utility systems is of critical importance.
- B. Connections to existing services or utilities or other work that requires the temporary shutdown of any existing operations or utilities is to be planned in detail with appropriate scheduling of the work and coordinated with the Owner.

3.3 CONSTRUCTION REVIEW

- A. Engineer will review and observe installation work to identify discrepancies by the Contractor with requirements of the contract documents.
- B. Review, observation, assistance, and actions by Engineer is not be construed as undertaking supervisory control of the work, or of methods and means employed by the Contractor. The Engineer's review and observation activities does not relieve the Contractor from the responsibilities of these contract documents.
- C. The fact that Engineer does not make early discovery of faulty or omitted work does not bar Engineer from subsequently rejecting this work and identifying the need for the Contractor to make the necessary corrections.
- D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor is not to claim against Engineer for an increase in the contract price, or for any payment on account of increased cost, damage, or loss.

3.4 - SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
27 00 10-01	General: Component datasheets for material and equipment items. Manufacturer's standardized schematic diagrams and catalog cuts are not acceptable unless applicable portions are clearly indicated and nonapplicable portions clearly deleted or crossed out. Installation is not to proceed until Owner has reviewed submittals for general conformance with the intent of the specifications, and specific conformance with the drawings		Prior to delivery

END OF SECTION

SECTION 27 10 10

BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements specifically applicable to Division 27 communications requirements.
- B. The Contractor is responsible for:
 - 1. Furnishing materials, labor, and equipment in accordance with this Section and the accompanying Drawings.
 - 2. Complete systems in accordance with the intent of these Contract Documents.
 - 3. Coordinating the details of facility equipment and construction for other specification divisions that affect the communications system work covered under this Division.
 - 4. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
- C. Intent of Drawings: Communication plan Drawings show only general locations of raceways, cable tray, equipment, and devices, unless specifically dimensioned.
- D. This Section specifies the requirements necessary to furnish, install, identify, and test products and materials listed below:
 - 1. Innerduct.
 - 2. Communication backboard.
 - 3. Equipment racks and cabinets.
 - 4. Wiring block systems.
 - 5. Modular patch panels.
 - 6. Cable management accessories.
 - 7. Ground busbar hardware.
 - 8. Equipment rack and cabinet ground bars.
 - 9. Telecommunications outlet faceplates and jacks.
 - 10. Unshielded twisted-pair (UTP) cable.
 - 11. Multi-pair backbone cable.
 - 12. Ground wire.
 - 13. Communication identification.
 - 14. Communications system testing (test result form provided as Appendix to this Section):
 - a. Horizontal UTP cable system testing (Section 27 10 20.13 – Horizontal UTP Cable Schedule and Test Summary).
- E. Related Sections:
 - 1. Appendices attached to end of this Section.

1.2 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various wide area network (WAN) and local area network (LAN) services (e.g., digital multiplexers,
- B. RS-232 controllers, Ethernet wiring hubs, Private Branch Exchange (PBX) switches, etc.).
- C. Backbone Media: The portion of the communications wiring system that interconnects communications rooms and entrance facilities; includes cabling and mechanical termination at the cross-connects.
- D. Building Communications Room (BCR): Room in each building used to distribute communications services to satellite communications rooms (SCRs), satellite communications cabinets (SCCs), and telecommunication rooms (TRs) in the same building and interconnect with the main communications room (MCR). Typically, the BCR contains passive equipment used for electrical protection (protectors) and building cross-connect. The BCR may also include active equipment used for LAN and serve the functions of an SCR.
- E. Communications Rooms: Collective term used to describe MCRs, BCRs, SCRs, SCCs, and TRs.
- F. Consolidation Point: A zone distribution box and a location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- G. Cross-Connect: Group of wall- or rack-mounted connection points (e.g., wiring blocks or fiber optic distribution units) used to terminate and administer building cabling.
- H. Cross-Connections: Jumpers and/or patch cords to join communications circuits at the cross-connect.
- I. Fiber Optic Distribution Unit (FDU): Wall- or rack-mounted cross-connect used to terminate and administer fiber optic cabling. Also known as optical fiber cross-connect.
- J. Horizontal Cross-Connect (HC): A cross-connect of horizontal cabling to other cabling.
- K. Horizontal Media: Portion of the communications wiring system that extends from SCRs, SCCs, or TRs to the outlet at the work area; includes cabling, outlets, and mechanical cable termination at the cross-connect and the outlet.
- L. Horizontal Pathways: Raceway, cable tray, access floors, and underfloor facilities used for the installation of horizontal media.
- M. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits (e.g., eight-position/eight-contact modular jacks).
- N. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.

- O. Main Communications Room (MCR): Room used to distribute communications services to BCRs on the campus and to interconnect campus services with the local exchange companies. Typically, the MCR contains passive equipment used for electrical protection (protectors) and main campus cross-connect. The MCR also includes active equipment used for PBX, WAN, and LAN.
- P. Optical Fiber Cross-Connect: See FDU.
- Q. Passive Equipment: Non-electronic hardware and apparatus; e.g., equipment racks, cable trays, electrical protection, wiring blocks, FDUs, etc.
- R. Patch Cord: Length of copper or fiber cable with connectors at each end used to join communication circuit at a cross-connect.
- S. Pathway: Raceway, sleeve, cable tray, access floor, underfloor system, or other facility used for the installation of communications media.
- T. POTS: Plain old telephone service.
- U. Protectors: Electrical protective devices used to protect against hazards, such as contact with electrical circuits, lightning, and above-normal voltages induced by fault currents on power circuits in proximity to a metallic communications circuit.
- V. Raceway: Channel designed expressly for holding wires and cables, e.g., conduit, surface raceway, and wireway.
- W. Satellite Communications Cabinet (SCC): Cabinet or group of cabinets which may serve the same purpose as an SCR.
- X. Satellite Communications Room (SCR): Room used to distribute communications services to work areas and to interconnect with the BCR. The SCR contains passive equipment used for cross-connecting and also includes active network equipment used for LANs.
- Y. Surface Raceway: Metal or nonmetal cable support trough with optional cover; not used in enclosed spaces.
- Z. Telecommunication Outlet (TO): The data or phone outlet located at a workstation or device with a telecom connections.
- AA. Telecommunications Room (TR): An enclosed space for housing telecommunications equipment, cable terminations, and cross-connects, that is the recognized location of the horizontal cross-connect.
- BB. AA. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross- connect facilities.
- CC. BB. Wireway: Metal or nonmetal cable support trough with cover usable in enclosed spaces.

- DD. CC. Work Area: A building space where users interact with telecommunications terminal equipment.

1.3 SYSTEM DESCRIPTION

- A. The communications distribution system consists of six major subsystems:
1. Backbone Pathways: Interbuilding and intrabuilding facilities, such as raceways and cable tray, used by the backbone communications distribution subsystem, to interconnect common carrier service providers and communications rooms.
 2. Horizontal Pathways: Intrabuilding facilities such as raceways and cable tray used by the horizontal communications distribution subsystem to connect SCRs, SCCs, and TRs with outlets located at the work area.
 3. Communications Room Distribution Subsystem: MCR, BCR, SCR, SCC, and TR passive equipment installations used to distribute communications services.
 4. Backbone Communications Distribution Subsystem: Interbuilding and intrabuilding backbone transmission media and cable terminations.
 5. Horizontal Communications Distribution Subsystem: Intrabuilding horizontal transmission media, outlets, and cable terminations.
 6. Work Area Communications Distribution Subsystem: Special-use telephones and components used to interconnect outlets and station equipment.

1.4 DESIGN CRITERIA

- A. Materials, equipment, and methods shall conform to the requirements of the following communications standards:
1. ANSI / TIA-568-C.0-2009, TIA Standard – Generic Telecommunications Cabling for Customer Premises.
 2. ANSI / TIA-568-C.1-2009, TIA Standard – Commercial Building Telecommunications Cabling Standard.
 3. ANSI / TIA-568-C.2-2009, TIA Standard – Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 4. ANSI / TIA-568-C.3-2008, TIA Standard – Optical Fiber Cabling Components Standard.
 5. ANSI / TIA-569-C-2012, TIA Standard – Telecommunications Pathways and Spaces.
 6. ANSI / TIA-606-B-2012, Administration Standard for Telecommunications Infrastructure.
 7. ANSI / TIA-607-B-2012, Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises.
 8. ANSI / TIA-862-A-2011, Building Automation Systems Cabling Standard for Commercial Buildings.
 9. TIA-526-7 2002(R 2012), TIA Standard – Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant.
 10. TIA-526-14-B 2010, TIA Standard – Measurement of Optical Power Loss of Installed Multi-mode Fiber Cable Plant.
 11. IEEE 802.3, Standard for Ethernet Connection Through Coaxial, Twisted-Pair, and Fiber Media.
 12. Related Standards and addendums to the Standards or referenced by the standards listed above.

- B. The following criteria applies:

1. The communications equipment room installations shall be as similar as possible.
 2. Provide electrical protection for interbuilding twisted-pair cabling installed underground or when routed outdoors exposed to lightning.
 3. Communication room and cabinet zoning shall restrict the maximum horizontal wiring physical length between cross-connects and a served outlet to 295 feet. Verify installed cable physical length does not exceed 295 feet.
- C. Compliance by the Contractor with the provisions of this Section does not relieve the Contractor of the responsibility for furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- D. Electrical components and systems manufactured within the scope of Underwriters Laboratories (UL) shall conform to the UL standards and be UL listed and labeled with an applied UL listing mark.

1.5 REGULATORY REQUIREMENTS

- A. Conformance to the latest codes and other legal requirements is the responsibility of the Contractor.
- B. Obtain permits and arrange inspections required by codes applicable to this Section and submit written evidence to Owner that the required permits, inspections, and code requirements have been secured.
- C. Twisted-pair communications cables shall conform to the National Electrical Code:
1. Article 725, Signal Circuits; for data and VoIP cabling.
 2. Article 800, Communication Circuits; for cabling that extends a circuit from a communications utility such as a DSL or PBX line.
- D. Fiber optic communications cables shall conform to the National Electrical Code Article 770, Optical Fiber Cables.

1.6 QUALIFICATIONS

- A. The Contractor shall have 6 years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the types of media or system component specified in the Contract Documents (e.g., Category 5e, 6, or 6A twisted-pair cable, multi-mode fiber, single-mode fiber, etc.). In the case of newer technologies that do not have a 3-year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Contractor shall be a currently certified installer of products.
- C. Additional WAN and LAN Qualifications: Minimum of 6 years' successful business experience in design and installation of systems like the type specified.
- D. Category 5e, 6, and 6A UTP and Fiber Optic Cable Technicians: Documented training and/or certification for the types of media and connectors specified.

- E. Project Manager, Engineers, Supervisors, and Principal Skilled Technicians: Minimum 6 years' experience in like work.

1.7 WARRANTY

- A. Install complete cabling solution per manufacturer's warranty requirements.
- B. Materials: Provide cables and materials in accordance with manufacturer's warranty.
- C. Workmanship: Install materials in accordance with manufacturer's installation requirements.

1.8 COORDINATION

- A. Coordinate location of equipment specified in this Division with other trades to avoid interference with work of other trades.

1.9 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide materials and equipment labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.
- B. Provide manufacturer's standard finish color, except where specific color is indicated.

2.2 CONDUIT AND FITTINGS

- A. Provide materials as specified in Section 26 05 33 – Raceways and Boxes for Electrical Systems.
- B. Conduit Supports – Conduit Clamps, Straps, and Supports: Galvanized steel, cadmium plated, or malleable iron for metallic conduit, nonmetallic for nonmetallic conduit.
- C. Conduit Seal: Listed product suitable for sealing space around installed cables to prevent gas, liquid, or dust to pass in or out of classified areas.

2.3 FLOOR PENETRATIONS

- A. Flush-Mount Floor Outlets: Flush-mounted outlet assembly with a fire rating listing for reinforced concrete or concrete-on-steel floor. Includes spaces for up to four RJ45-type jacks with slide covers.
 - 1. Communications/Power: Legrand/Wiremold/Walker RC4 Series Poke-Thru.

- B. Furniture Feeds: Low-profile service head with a fire rating for routing communications and optionally power cable through concrete floor and into modular furniture units.
 - 1. Communications Only: Hubbell HPW PT2FIT, large capacity poke-thru.
 - 2. Communications/Power: Legrand/Wiremold RC9CFFTC Series Service Head.

2.4 SURFACE RACEWAY

- A. Material and Construction: Sheet metal or nonmetallic trough with optional cover, intended for use only in dry, exposed locations, in sizes shown on Drawings.
- B. Boxes, Extensions, and Fittings: Designed for use with raceway system to be provided.

2.5 CABLE TRAYS

- A. Cable Runway:
 - 1. Tubular Style Runway: Ladder type with 2-inch stringer height with welded rungs.
 - 2. Solid Bar Style Runway: Ladder type with 2-inch stringer height with welded rungs.
 - 3. Rungs: 1/2-inch by 1-inch steel C-channel shape with rounded edges, spaced on 9-inch centers.
 - 4. Width: As indicated.
 - 5. Finish: Flat black powder coat.
 - 6. Fittings and Accessories: Fittings, supports, splices, etc., for the runway system shall be installed to provide a complete assembly – including fasteners, hardware, and other items required to complete the installation as indicated on the Drawings.
 - 7. UL Classified as a bonding conductor.

2.6 INNERDUCT

- A. Solid Innerduct:
 - 1. Nonrated Indoor/Outdoor Innerduct, Underground or Within Raceway Applications: Corrugated, ribbed, or smooth-walled, semi-rigid PVC or heavy-wall polyethylene tubing.
 - 2. Riser-Rated Indoor Innerduct, Exposed Applications: Corrugated, ribbed, or smooth-walled semi-rigid nonflammable PVC tubing which meets UL 94V-O vertical flame test for general applications.
 - 3. Plenum-Listed Indoor Innerduct: Corrugated walled innerduct for use in plenum air-handling spaces.
 - 4. Riser-Rated Split Corrugated Innerduct, Exposed Applications: Corrugated wall, semi-rigid, nonflammable PVC tubing which meets UL 94V-O vertical flame test for general applications with longitudinally slit wall.
 - 5. Sizes: As indicated on the Drawings or schedules.
 - 6. Innerduct Couplings: Metallic or nonmetallic quick connect, reverse threaded, and Schedule 40 couplings for connecting sections of installed innerduct.
 - 7. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing the outside walls of one or more innerduct ends and inside wall of
 - 8. 4-inch-inside-diameter conduit.

9. Innerduct Plugs: Proper size compression-type innerduct plug for sealing innerduct with eyebolt for securing pull tape, attached to plug with wing nut for hand tightening.
10. Innerduct Caps: Removable push-in caps for plugging innerduct.

2.7 PULL TAPE

- A. Pull Tape: Measuring and pulling tape constructed of synthetic fiber with plastic jacket, printed with accurate sequential footage marks.

2.8 PENETRATION SEALING MATERIALS

- A. Duct Water Seal: Product suitable for closing underground and entrance conduit openings where innerduct or cable is installed to prevent the entry of gases, liquids, or rodents into the structure.
- B. Firestopping: Intumescent fire barrier penetration sealing material.

2.9 COMMUNICATIONS TERMINATION BACKBOARDS

- A. Termination Backboards: Fire-retardant, AC-grade void-free plywood furnished in sheets measuring 4 feet wide, 8 feet long, and 3/4 inch thick.

2.10 EQUIPMENT RACKS AND CABINETS

- A. Floor-Supported Equipment Racks:
 1. Two-post rack as indicated on drawings with EIA hole pattern.
 - a. Acceptable Manufacturers:
 - 1) Chatsworth.
- B. Cabling Management Sections:
 1. Acceptable Manufacturers:
 - a. Chatsworth.
- C. Equipment Rack Accessories:
 1. Installation kit for concrete floor including concrete anchors, studs, nuts, and washers.
 2. Line-up spacer kit for attaching two racks mounted side by side including spacer plates, cap screws, nuts, and washers.

2.11 WIRING BLOCK SYSTEMS

- A. Acceptable Manufacturers:
 1. Simon S66 M1-50.

2.12 MODULAR PATCH PANELS

- A. Acceptable Manufacturers:
 1. Leviton.

- B. Modular Patch Panel with Integrated Ports: Eight-position/eight-conductor modular jacks integrated as one panel using the EIA/TIA-T568B wiring label, arranged for 19-inch EIA equipment rack mounting, equipped with printed wiring connections and 110 IDC wiring block input. Examples:
 - 1. Leviton Modular Jack Panel, Category 6:
 - a. 24 Jacks: 49255-H24, Flat Panel.

2.13 CABLE MANAGEMENT ACCESSORIES

- A. Open and Closed Cable Distribution Rings: J-hooks, C-rings, and D-rings made of plated steel or plastic.
- B. Wire Distribution Post: Plastic spool/post for mounting on backboards with screw to hold jumper wires in place.
- C. Jumper Trough: White fire-retardant, molded plastic frame which will accommodate jumper wire and/or patch cords (e.g., Panduit jumper trough.
 - 1. With Legs: P110JTW-X.
 - 2. Without Legs: P110JT-X.

2.14 GROUNDING AND BONDING HARDWARE

- A. Ground Busbar: Solid copper plate, predrilled for two-hole lug connections, with 1/4-inch minimum thickness, for wall and backboard mounting using standoff insulators.
 - 1. 4-Inch by 10-Inch Product Example: Chatsworth busbar 10622-010.
 - 2. 4-Inch by 20-Inch Product Example: Chatsworth busbar 10622-020.
- B. Ground Terminal Block: At equipment mounting locations (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.
- C. Ground Wire: Grounding conductors of the size and type shown on the Drawings or use a minimum of 6 AWG stranded copper wire with green thermoplastic insulation.
- D. Rack Vertical Bus Bar: Pre-drilled vertical bus bar for consolidating rack equipment grounds. Example: Chatsworth 40160-072.

2.15 TELECOMMUNICATIONS OUTLETS

- A. Acceptable Manufacturers:
 - 1. Leviton
- B. Modular Telecommunications Outlet System:
 - 1. Single Gang, White Face Plate for a Flush-Mount Box.
 - a. Modular Sixplex Outlet Faceplate:
 - 1) Leviton QuickPort #41108-RW8.
 - 2. Jacks for Modular Outlets:
 - a. Leviton
 - 1) Category 6 Jack, R03-6G108-01O.

2.16 SUSPENDED CABLE SUPPORTS

- A. Supports:
 - 1. Nylon J-hooks used with structure-attached independent support wires, rods, or structural fasteners. Example: Erico/Caddy ER-CAT48HP or Panduit JP131W-L20 or JP2W-L20 J-hook.

2.17 UNSHIELDED TWISTED-PAIR HORIZONTAL CABLE

- A. Acceptable Manufacturers:
 - 1. Network/Data: Berk-Tek LANmark – 6
 - 2. Voice: Berk Tek LANmark - 350
- B. UTP Horizontal Cable: 100-ohm UTP plenum cable for use in the horizontal distribution subsystem shall meet or exceed the requirements of TIA/EIA 568-B.2, 100-ohm UTP Cable.
 - 1. EIA/TIA Category: 5e or 6.
 - 2. Conductors: WECO color-coded 24 AWG solid copper thermoplastic-insulated conductors twisted together in pairs; rated 60 degrees C and 300 volts.
 - 3. Assembly: Pairs formed together into multi-pair groups and enclosed by a thermoplastic jacket.
 - 4. Four-pair cable sheaths must be clearly factory colored or color labeled at intervals not greater than 1 foot to easily differentiate between up to four cables.

2.18 TWISTED-PAIR PATCH CORDS

- A. Acceptable Manufacturers:
 - 1. Panduit/General.
 - 2. Commscope.
 - 3. Siemon.
- B. Modular Plug to Modular Plug: Factory-assembled, eight-position modular plug-ended. Category as indicated on Drawings or cable schedules, four-pair 24-AWG stranded conductor UTP patch cord with straight-through wiring that can be used between eight-position/eight-conductor modular patch panel ports to complete circuits. Patch cord performance grade matched to the horizontal cable grade installed.

2.19 IDENTIFICATION MATERIALS

- A. General:
 - 1. Identification plates and labels shall be attached to avoid removal or shifting through accidental contact, normal activity, environmental conditions, or material aging.
 - 2. Adhesives shall be permanent and provide a secure bond that does not become loose due to aging or interaction with the mounting surface or environment.
 - 3. Non-engraved labels shall be machine-printed in nonfading permanent ink that distinctly contrasts to the background material; handwritten marking is not permitted. Incidental exposure to water or other liquids normal to the environment shall not cause marking to run or fade.
 - 4. Lettering shall be in uppercase unless specifically noted otherwise in the Drawings or schedules.

- B. Nameplates: Engraved laminated plastic, minimum 3/16-inch-high letters on a contrasting background.
- C. Cable Labels: Flexible tabs permanently attached to cable by adhesive, clear plastic jacket, and/or plastic tie-wraps located 12" from each end of cable.
- D. Wiring Block Labels: Cardboard-like strips that slip inside clear plastic holders located on protector panels and wiring blocks.
- E. Telecommunication Outlet Labels: Rectangular-shaped adhesive-backed tabs.
- F. Miscellaneous Labels: Adhesive-backed tabs or plastic tape that are applied to smooth surfaces to identify materials and equipment.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Install system components under the direction of qualified personnel; appearance and workmanship shall meet or exceed industry, product manufacturer, and Owner standards.
- B. Install and test cable, material, and equipment in accordance with manufacturers' instructions.
- C. Coordinate work with equipment suppliers and other contractors.

3.2 SERVICE CONTINUITY

- A. Continuous operation of the Owner's existing systems and public utility systems is of critical importance. Potential impact on operating systems shall be fully explained and coordinated with Owner.
- B. Connections to existing services or utilities or other work that requires the temporary shutdown of any existing operations or utilities shall be planned in detail with appropriate scheduling of the work and shall be coordinated with Owner.

3.3 CONSTRUCTION REVIEW

- A. Owner will review and observe installation work to ensure compliance by the Contractor with requirements of the Contract Documents.
- B. Review, observation, assistance, and actions by Engineer shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. Engineer's review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.
- C. The fact that Engineer does not make early discovery of faulty or omitted work shall not bar Engineer from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.

- D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against Engineer for an increase in the Contract price, or for payment on account of increased cost, damage, or loss.

3.4 PROTECTION DURING CONSTRUCTION

- A. Protect products from effects of moisture, corrosion, and physical damage during construction. Except during installation activity in a section, keep openings in conduit, wireway, and innerduct capped with manufactured seals.

3.5 GENERAL INSTALLATION

- A. Horizontal Cable Support: Where specified on the Drawings between TOs and raceway or cable tray entrances, support horizontal cables from structure using J-hooks:
- B. Remove and replace ceiling tile as required to obtain access for completing the Contractor's portion of the project. Repair ceiling tile damage caused by this activity.
- C. Fire-Rated Wall and Floor Penetrations:
 - 1. Inspect firestopping installation by others between building construction and innerduct and conduit, sleeves, wireway, and cable tray to verify integrity of installation.
 - 2. The Contractor is responsible for locating and providing fire-rated wall penetrations where required.
 - a. For Exposed Cable:
 - 1) Before Cable Installation: Install conduit sleeves with insulating throat bushings and fire-barrier sealing systems in openings where open cable passes through fire-rated walls and floors.
 - 2) After Cable Installation: Install intumescent fire barrier penetration sealing materials between cables and sleeves or install fire barrier sealing systems.
 - b. For Raceways: After cable installation, install intumescent fire barrier penetration sealing materials between cables and conduit, innerduct, or wireway at exposed penetration locations.
 - c. For Cable Trays:
 - 1) During Cable Installation: Protect firestopping materials throughout the construction period in a clean and properly protected condition to maintain each assembly without any indication of damage.
 - 2) After Cable Installation: Restore fire barrier penetration sealing materials to provide required protection.
 - 3. Protect adjacent surfaces from damage during water seal or firestop installation, repair damage.
- D. Identify and label the system in accordance with submitted and approved plan.
- E. Place blank covers over unused/unterminated outlet and outlet jack openings.

3.6 IDENTIFICATION INSTALLATION

- A. Degrease and clean surfaces to receive nameplates or labels.
- B. Install identification parallel to equipment lines and visible from 3 feet. Install cable labels at both ends of each cable, near end of sheath, such that tracing is readily performed.
- C. Secure nameplates using screws, rivets, or suitable adhesive.
- D. Basic Cable and Faceplate Identification Scheme: Cables, faceplates, jacks, and patch panel ports shall have a consistent "R-NN" format, where:
 - 1. R = Patch panel letter name
 - 2. NN = Port number.
 - 3. Labeling information shall be recorded on as-built drawings, and test documents shall use the same identification system to permit correlation of test data with specific cable.
- E. Innerduct: Provide labels for each innerduct at terminating ends and at other exposed appearances (e.g., building entrance locations, manholes, handholes, pull boxes, etc.). At minimum, each label must include far-end and unique innerduct identifiers.
- F. Horizontal Cable: Label horizontal cables to identify the unique outlet jack identification number.
- G. Wiring Blocks:
 - 1. Label wiring block terminations using the following color-coded inserts to identify the type of media or equipment terminated:

Termination	Color
Horizontal outlet cabling	Blue
MCR to BCR campus/backbone cabling	White
BCR to SCR backbone/riser cabling	Gray
Local exchange carrier cabling	Green
PBX and other common equipment cabling	Purple
LAN, auxiliary circuits, etc.	Yellow
Transmission electronics equipment cabling	Orange

- 2. Identify backbone cable wiring block positions with the cable number and pair numbers.
 - 3. Identify horizontal wiring block positions with the unique outlet jack identification numbers.
- H. Modular Jack Panel:
 - 1. numbers.

- I. Patch Cord Cross-Connects: Label copper and fiber-optic patch cords at each end between 3 and 12 inches from the cable end. Label patch cord cables to identify a unique cable number comprised of the terminating and equipment identifier.

3.7 SURFACE RACEWAY INSTALLATION

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components to provide a continuous grounding path.
- D. Fastener Option: Use clips and straps suitable for the purpose.

3.8 CABLE TRAY INSTALLATION

- A. Installation: In conformance with NEMA requirements and in accordance with manufacturer's instructions.
- B. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 feet maximum. Trays shall be level with respect to grade, plus or minus 1/8 inch per 10 feet or 1/2 inch cumulative.
- C. Use expansion connectors where indicated in NEMA standards or where cable tray crosses expansion or seismic joints.
- D. Cut standard straight sections to length in field. Splice the straight sections and fittings to maintain the UL Classification of the tray as a bonding conductor.
- E. Provide bonding continuity between cable tray sections and fittings in accordance with manufacturer's instructions. Make connections to aluminum tray and fittings using an antioxidant compound.

3.9 INNERDUCT INSTALLATION

- A. Innerduct Usage Schedule:
 - 1. Under-slab and Underground Raceways: Outdoor or indoor innerduct.
 - 2. Above-Ground Raceways, Exterior and Interior: Indoor innerduct.
 - 3. Interior Exposed Locations, Including Cable Tray Installations:
 - a. Non-plenum Areas: Indoor innerduct.
 - b. Plenum Areas: Plenum-listed innerduct.
 - 4. Cable Tray to Equipment-Mounting Transitions: Split-corrugated innerduct.
 - 5. Note: In case of conflict between this Section and the Drawings or Schedules, request clarification from Owner.
- B. Pull innerduct through conduit and wireways, or place innerduct in cable trays using continuous un-spliced lengths of innerduct between manholes, pull boxes, and/or section termination points.
- C. Cut innerduct square; deburr cut ends.

- D. Bring innerduct to the shoulder of fittings and couplings and fasten securely.
- E. Wipe innerduct and fittings clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure according to cement manufacturer's instructions.
- F. Provide suitable innerduct slack in manholes, handholes, pull boxes, and at turns to ensure that there is no kinking or binding of the tubing.
- G. Make changes in direction of communications innerduct runs with sweeps of the longest possible radius and at least 10 times the inside diameter of the innerduct.
- H. During innerduct placement avoid excessive tension which can deform the innerduct. Inspect the innerduct following placement and replace any damaged sections.
- I. Innerduct Mountings, Hangers, and Attachments: When exposed indoors or in manholes, hold innerduct firmly in place using independent support.
 - 1. Install straps, hangers, and other similar fittings adequate to support loads and so as not to damage innerduct.
 - 2. Do not fasten innerduct supports to steam pipes, water pipes, duct work, ceiling grid support wires, or other utilities.
 - 3. Do not allow innerduct sag to contact the ceiling grid or light fixtures.
- J. Underground Conduit Installation: After innerduct is installed in conduit entering structures, seal openings inside conduit around innerduct at first box or outlet to prevent the entrance of gases, liquids, or rodents into the structure. Use suitable plastic-expandable compound (e.g., duct water seal).
- K. Manhole and Handhole Installation:
 - 1. At locations where innerduct will be continuous through a manhole or handhole, allow sufficient slack for securing the innerduct to the side of the vault while maintaining the required minimum bend radius. Secure the innerduct to the racking.
 - 2. At manholes serving as a junction location, pull the exposed end of the innerduct to the far end of the vault, install manufactured duct plugs, and secure to cable racks.
 - 3. At other locations where the ends of innerduct sections appear in a manhole or handhole, join the pull tape, and then splice innerduct sections together using watertight couplings which do not reduce the inside diameter of the innerduct.
- L. Indoor Conduit Installation:
 - 1. Arrange innerduct neatly, cut to proper length, and remove surplus. Provide trained and bundled innerduct pigtailed extending at least 18 inches beyond exposed conduit openings.
 - 2. At locations where the ends of innerduct sections appear in a pull box, join the pull tape, and then splice innerduct sections together using couplings which do not reduce the inside diameter of the innerduct.
- M. Indoor Exposed Installation: Tie-wrap innerduct to one side of vertical ladder rack every 2 feet minimum, and to one side of horizontal ladder-type cable tray every 5 feet minimum.

- N. Following installation, visually inspect innerduct, remove any burrs at openings, and, if necessary, clean innerduct interior.
- O. Label innerduct as required in this Section.

3.10 PULL TAPE AND DUCT PLUG INSTALLATION

- A. Following innerduct installation, install pull tape with preprinted foot markers in innerduct sections. Tie the pull tape securely to wall racking at each location.
- B. Following innerduct and pull tape installation, cap or plug innerduct with manufactured seals to prevent moisture or foreign matter from entering until cable installation starts.

3.11 PENETRATIONS

- A. Seal conduit and innerduct entering structures at the first box or outlet to prevent entrance of gases, liquids, or rodents into the structure.
 - 1. Conduit with Innerduct Installed: Suitable duct water seal between conduit and innerduct.
 - 2. Empty Innerduct: Removable screw-tight duct plugs.
 - 3. Cable Installed: Suitable duct water seal between innerduct and cable.

3.12 COMMUNICATIONS ROOM DISTRIBUTION EQUIPMENT INSTALLATION

- A. Install communications backboards, equipment racks and cabinets, boxes, raceways, framing, cable tray, wiring blocks, , and other related materials and equipment plumb as shown on the Drawings and in accordance with the manufacturer's specifications and procedures.
- B. Finish paint communications backboards with durable, fire-retardant paint to match the wall color.
- C. Provide split-corrugated innerduct to protect fiber optic cables at transitions from cable tray systems to equipment cabinets and racks.
- D. Furnish and install wire and hardware required to properly ground and bond communications cable and equipment.
 - 1. Install building and/or telecommunications ground busbars as shown on the Drawings.
 - 2. Connect a pigtail extension from the building grounding facility to the communications room ground bus hardware as shown on the Drawings.
 - 3. Bond each equipment rack to overhead runway with 6 AWG insulated stranded copper pigtail.
 - 4. Install bonding jumper across each runway joint using minimum 6 AWG insulated stranded copper wire.
- E. Ground metallic raceways, cable trays, cable shields, equipment racks, equipment cabinets, and other metallic equipment located in a communications room to the telecommunications ground busbar using a minimum of 6 AWG insulated copper wire.

3.13 RACEWAY PREPARATION

- A. Verify that installed raceways, cable tray, equipment cabinets, equipment racks, cross-connect systems, cabling, and local area network systems are suitable for use and ready to receive work.
- B. Use mandrel to clean and thoroughly swab raceway systems before installing cable.

3.14 GENERAL COMMUNICATIONS CABLING METHODS

- A. Provide protection for exposed cables where subject to damage.
- B. Install cable in raceway and cable tray after interior of building has been physically protected from the weather and mechanical work likely to injure conductors has been completed.
- C. Pull tape (muletape) with preprinted foot markers is usually provided when conduit and innerduct are installed; if not, provide pull tape in each empty communications conduit containing a bend and over 10 feet in length.
- D. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal.
- E. Arrange wiring neatly, cut to proper length, and remove surplus wire.
- F. Where connection of cables installed under this Section are to be made by others, provide pigtails of adequate length for neat, trained, and bundled connections.
- G. Install communications cable in accordance with manufacturer's instructions. Place cable so as not to exceed the pulling tension or minimum cable bend radius limits specified by the manufacturer.
- H. Utilize continuous un-spliced lengths of copper conductors or fiber optic strands between splice enclosures and/or termination points.
- I. The number of twisted pairs or fiber strands specified for each cable shall be terminated, tested, and functional.
- J. Provide suitable cable slack in vaults, handholes, boxes, outlets, and at turns to ensure that there is no kinking or binding of the sheath. In the horizontal cable system, include slack in length calculations to ensure that physical horizontal cable lengths do not exceed 90 meters (295 feet). Horizontal slack requirements:
 - 1. UTP: 3 meters (10 feet) in closets, 30 cm (12 inches) at outlet.
 - 2. Optical Fiber: 3 meters (10 feet) in closets, 1 meter (3.3 feet) at outlet.
- K. Cable Management Mountings, Hangers, and Attachments:
 - 1. Hold communications cable firmly in place using independent support.
 - 2. Install straps, mountings, hangers, J-hooks, threaded or nonthreaded support rods, distribution rings, cable tie mountings, and other similar fittings adequate to support loads with ample safety factors and so as not to damage, bind, or deflect cable. Do not use plumbers' perforated straps as a means of support.

3. Do not fasten communications cable supports to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires used to support ceiling grid. Do not allow communications cables to make contact with ceiling tiles, ceiling grid support wires, or lighting fixtures.
- L. Communications Cable Ties:
1. Install cable ties loosely so as not to bind the cable sheath or distort the placement of twisted-pair components.
 2. Plenum Building Areas: Where cable passes through open return air space, use plenum-rated plastic or stainless-steel cable ties.
 3. Non-plenum Building Areas: Use conventional flame-retardant nylon ties with a consistent natural or white color.
 4. Exterior and Underground Locations: Use black plastic UV-resistant cable ties.
- M. Communications Jumpers and Patch Cords: Route and arrange cross-connects neatly in the wire management trays and troughs provided as part of the cross-connect system. Cut wire to proper length and remove surplus.

3.15 UNSHIELDED TWISTED-PAIR CABLE INSTALLATION

- A. Place UTP cable so as to maintain the minimum cable bend radius limits specified by the manufacturer or the following, whichever is larger:
1. Horizontal Four-Pair UTP Cables:
 - a. Termination Points: Eight times the cable diameter.
 - b. Other Locations: Four times the cable diameter.
 2. Multipair UTP Cables: Maintain a minimum bend radius of ten times the cable diameter.
- B. To avoid stretching four-pair horizontal cable conductors during installation, do not exceed a 25-pound force pulling tension (tensile loading).
- C. Use wiring block and/or connector manufacturer's recommended tools, with the proper sized anvils, for copper punch down, wire wrap, and crimp terminations. Stuffer caps are not permitted.
- D. Directly terminate twisted-pair cable on wiring blocks in standard WECO color-code order.
- E. Cable Jackets: To reduce untwisting of pairs, maintain the twisted-pair cable jacket as close as possible to the point of termination.
1. Multipair Cable: Strip back only as much cable jacket as is required to terminate on connecting hardware.
 2. Horizontal Cable: Strip back no more than 1 inch of cable sheathing.
- F. Pair Twist: Preserve wire pair twists as closely as possible to the point of mechanical termination to minimize signal impairment; limit untwisting as follows:
1. Multipair Cables: No greater than 1 inch.
 2. Category 5e, 6, and 6A Horizontal Cables: No greater than 1/2 inch.
- G. UTP Patch and Station Cords: Field assemble unshielded twisted-pair patch cords terminated as shown on the Drawings.

1. Use stranded UTP cable designed for use as patch cordage.
2. Provide modular plugs designed for installation on the wire type, AWG size, and flat/oval or round sheath shape of the cable used.
3. Make straight through wiring connections unless otherwise indicated on the Drawings.

3.16 INSTALLED-CABLE FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Verify cables are terminated according to the Drawings and shield grounding, cable support, and terminations are properly installed.

3.17 CROSS-CONNECT PREPARATION

- A. Verify that cable raceways, equipment cabinets, equipment racks, cross-connect systems, cabling, and local area network systems are ready to receive work.

3.18 COMMUNICATIONS SYSTEMS INSPECTION AND TESTING

- A. Perform inspections and tests specified hereinafter and as indicated under communications distribution subsystems specified in other sections.
- B. General Inspection Requirements:
 1. As part of any performance test, inspect cable, material, and equipment for physical damage, continuity, and proper connection.
 2. Verify identification and labeling at required locations for visibility, condition, legibility, and accuracy.
- C. General Test Requirements:
 1. At the completion of communications system installation and at such time as Owner may indicate, conduct performance tests and complete corresponding test reports for delivery to Owner.
 2. Furnish test equipment and personnel required for tests. Test shall be calibrated within 1 year of the test being performed. Technicians performing the tests require current training certification for the equipment being used.
 3. Tests shall demonstrate that cable, material, and equipment components and assemblies operate in accordance with the Contract Documents.
 4. Unless specified elsewhere, provide at minimum 48 hours' notice to Owner of the time and location of the test to be performed.
- D. General Test Report Requirements:
 1. Each test report shall include the following sections:
 - a. Project identification, contractor, and test date.
 - b. Scope of testing.
 - c. List of equipment used in the test with a photocopy of the calibration certificate.
 - d. List of technician(s) performing the tests identified in the scope of testing with a photocopy of their training/certification documentation.
 - e. Summary of Test Results: The summary is to be developed and completed by the Contractor.

- f. Individual Test Datasheets: The individual test datasheets are to be developed and completed by the Contractor. Each sheet shall contain identification sufficient to correlate test result with installed cable.
 - 2. Report Media:
 - a. Prepare test reports on 8-1/2- by 11-inch paper providing reproducible quality printing.
 - b. The individual test data reports may be submitted on electronic media if software needed to read the media is also provided.
- E. Cables with pairs that fail to meet performance test criteria and defective terminating devices shall be replaced by the Contractor free of charge. Test reports shall include test data from both the cable that failed and its replacement cable.

3.19 HORIZONTAL UNSHIELDED TWISTED-PAIR CABLE SYSTEM TESTING

- A. Link Test Configuration: Perform metered field tests on each four-pair UTP cable link through the wiring block, patch panel, and/or TO terminations at each end of the cable section using the basic link test configuration described in ANSI/TIA/EIA 568-C.2.
- B. Channel Test Configuration: Perform metered tests on each four-pair UTP cable channel, including cabling sections, cross-connect equipment, jumper wire and/or patch cords, TOs, and work area station cords through the connectors at each end, but not including connections to active equipment using the channel test configuration described in ANSI/TIA/EIA 568-C.2.
- C. Horizontal Performance Tests:
 - 1. Use field test instrument(s) capable of the following swept/stepped frequency voltage measurements in accordance with the performance parameters required by EIA/TIA-568-C.2.
 - a. Category 5e: Frequencies up to 100 MHz.
 - b. Category 6: Frequencies up to 250 MHz.
 - c. Category 6A: Frequencies up to 500 MHz.
 - 2. Test each horizontal link or channel pair to verify/determine wire map, length, attenuation, and near-end crosstalk (NEXT).
 - 3. Test voice links that exceed 90m in length for wire map, opens, shorts, crossed pairs, and dial tone.
 - 4. The TIA/EIA 568-C.2 standard allows for a 10 percent uncertainty in the nominal velocity of propagation of signals in a UTP cable when determining the cable length with an electronic tester. If during a test for a data link the tester identifies a length longer than 90 meters (295 feet), verify the physical length of the cable does not exceed 90 meters.
- D. Test Reports: Include field test results for each pair, including cable link length.
 - 1. The test summary will include:
 - a. Cable identification as it appears on the cable schedule.
 - b. Cable identification as it appears on the individual test reports.
 - c. Cable identification as it is labeled according to the Specifications.
 - d. Pass or fail status.
 - 2. The individual test datasheet will consist of the automated printout produced by the cable scanning equipment.

3.20 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
27 10 10-01	Qualifications for copper cabling.		
27 10 10-03	Cable Tray		
27 10 10-05	Innerduct		
27 10 10-06	Pull Tape		
27 10 10-07	Equipment Racks		
27 10 10-08	Vertical Cable Management		
27 10 10-09	Equipment Racks Accessories		
27 10 10-11	Wiring Blocks		
27 10 10-12	Modular Patch Panels		
27 10 10-14	Cable Management Accessories		
27 10 10-15	Ground Bus Bars		
27 10 10-16	Outlet Face Plates		
27 10 10-17	Copper Cable Jacks		
27 10 10-18	Suspended Cable Supports		
27 10 10-20	Horizontal UTP Copper Cable		
27 10 10-26	Twisted-Pair Copper Patch Cords		
27 10 10-28	Identification Materials		
27 10 10-29	Copper Cable Test Reports		10 Days after testing and prior to project completion
27 10 10-30	Fiber Optic Cable Test Reports		10 Days after testing and prior to project completion

END OF SECTION

SECTION 28 46 21.11

ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control panel.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Air-sampling smoke detectors.
 - 5. Heat detectors.
 - 6. Notification appliances.
 - 7. Device guards.
 - 8. Magnetic door holders.
 - 9. Graphic annunciator.
 - 10. Addressable interface device.
 - 11. Digital alarm communicator transmitter.
 - 12. Network communications.
 - 13. System printer.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

9. Include performance parameters and installation details for each detector.
 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
 - d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
 - e. Locate detectors according to manufacturer's written recommendations.
 - f. Show air-sampling detector pipe routing.
 12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level II minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

1.5 Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.

4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.

2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Automatic sprinkler system water flow.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
 2. Identify alarm and specific initiating device at fire-alarm control panel.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Activate voice/alarm communication system.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 9. Activate emergency lighting control.
 10. Record events in the system memory.
 11. Record events by the system printer.
 12. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. User disabling of zones or individual devices.
 3. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire-alarm control unit.
 5. Ground or a single break in internal circuits of fire-alarm control unit.
 6. Abnormal ac voltage at fire-alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
 10. Voice signal amplifier failure.
- E. System Supervisory Signal Actions:
1. Initiate notification appliances.
 2. Identify specific device initiating the event at fire-alarm control panel and remote annunciators.
 3. Record the event on system printer.
 4. After a time, delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 5. Transmit system status to building management system.
 6. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements and compatibility with existing site network and monitoring system used on the Hurst Bell campus available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bosch Security Systems.
 2. Faraday.
 3. Fike Corporation.
 4. Fire-Lite Alarms.
 5. GAMEWELL.
 6. GE UTC Fire & Security; A United Technologies Company.
 7. Mircom Technologies, Ltd.
 8. Notifier.
 9. Siemens Industry, Inc.; Fire Safety Division.
 10. Silent Knight.
 11. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, two lines of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Initiating Device Circuits (IDC): NFPA 72, Class A.
 2. Notification Appliance Circuits (NAC): NFPA 72, Class B.
 3. Signaling Line Circuits (SLC): NFPA 72, Class A
 4. Install no more than 50 addressable devices on each signaling-line circuit.
 5. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One USB port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.
- E. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- F. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.
- H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

- a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
- 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
- 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium
- M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.
 - 3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - 4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268, operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire type.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.
- B. Photoelectric Smoke Detectors:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - 4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- F. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 1. Rated Light Output:
 - a. 15/30/75/115 cd.
 - b. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, white.
- G. Voice/Tone Notification Appliances:
1. Comply with UL 1480.
 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 3. High-Range Units: Rated 2 to 15 W.
 4. Low-Range Units: Rated 1 to 2 W.
 5. Mounting: Flush in finished areas and surface mounted and bidirectional in unfinished areas.
 6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. General:
1. Include address-setting means on the module.
 2. Store an internal identifying code for control panel use to identify the module type.
 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Control Module:
1. Operate notification devices.
 2. Operate solenoids for use in sprinkler service.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- C. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 feet.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- F. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

- G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to activate emergency lighting control.
 - 5. Supervisory connections at valve supervisory switches.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 32 80 00

LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Documents, as listed on the Table of Contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made a part of this Section.
- B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the Work of this trade.

1.2 SUMMARY OF WORK

- A. The Work of this Section consists of furnishing all work and materials, appliances, tools, equipment, facilities, transportation, and services necessary for and incidental to performing all operations in connection with the installation of underground sprinkler irrigation system complete, as shown on drawings and/or specified herein. When the term "Contractor" is used in this Section, it shall refer to the irrigation Subcontractor.

1.3 QUALITY ASSURANCE

- A. The following Codes, Regulations, Reference Standards, and Specifications apply to work included in this Section: ASTM: D2241, D2464, D2466, D2564 and D2855.

1.4 WARRANTY AND MAINTENANCE

- A. The Contractor shall warranty material and workmanship for one year after final acceptance including repair and replacement of defective materials, workmanship, and repair of backfill settlement.
- B. Maintenance during warranty shall include, but not necessarily be limited to, the following:
 - 1. Adjustment of sprinkler height and plumb to compensate for settlement and/or plant growth.
 - 2. Backfilling of all trenches.
 - 3. Adjustment of head coverage (arc of spray) as necessary.
 - 4. Unstopping heads plugged by foreign material.
 - 5. Adjustment of controller as necessary to insure proper sequence and watering time.
 - 6. All maintenance necessary to keep the system in good operating order. Repair of damage caused by vandals, other contractors or weather conditions shall be considered extra to these specifications.
- C. Warranty and maintenance after final acceptance does not include alterations as necessitated by re-landscaping, re-grading, addition of trees or the addition, and/or changes in sidewalks, walls, driveways, etc.

- D. Maintenance shall continue for one month after final acceptance.

1.5 SUBMITTALS:

- A. The Contractor shall submit shop drawings or manufacturer's "cut sheet" for each type of sprinkler head, pipe, controller, valves, check valve assemblies, valve boxes, wire, conduit, fittings, and all other types of fixtures and equipment proposed to be installed on the job. The submittal shall include the manufacturer's name, model number, equipment capacity, and manufacturer's installation recommendation, if applicable, for each proposed item.
- B. No partial submittal will be accepted, and submittals shall be neatly bound into a brochure and logically organized. After the submittal has been approved, substitutions will not be allowed except by written consent of the Owner's representative.
- C. Shop drawings shall include dimensions, elevations, construction, details, arrangements, and capacity of equipment, as well as manufacturer's installation recommendations.

1.6 APPROVED EQUAL SUBSTITUTIONS

- A. Several items in this Section and on the plans are specified by a manufacturer's brand name and catalog number, followed by the phrase "or approved equal". This is not intended to unduly restrict competitive procurements or bidding but is done to assure a minimum standard of quality which is believed to be best for the item specified and to match existing equipment.

1.7 CODES/PERMITS

- A. All work under this Section shall comply with the provisions of these Specifications, as illustrated on the accompanying drawings, or as directed by the Owner and shall satisfy all applicable local codes, ordinances, or regulations of the governing bodies and all authorities having jurisdiction over this Project.
- B. Installation of equipment and materials shall be done in accordance with requirements of the National Electrical Code, City Plumbing Code, and standard plumbing procedures. The drawings and these Specifications are intended to comply with all the necessary rules and regulations; however, some discrepancies may occur, the Contractor shall immediately notify the Landscape Owner's representative in writing of the discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with the regulations shall be paid for as covered by these Contract documents.
- C. The Contractor shall give all necessary notices, obtain all permits, and pay all costs in connection with his work; file with all governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver to the Owner.
- D. The Contractor shall include in the work any labor, materials, services, apparatus, or drawings in order to comply with all applicable laws, ordinances, rules, and regulations whether or not shown on the drawings and/or specified.

- E. The installation of the irrigation system shall be made by an individual or firm duly licensed under Article No. 8751 VTCS, Titled "Licensed Irrigators Act", S.B. No. 259 as passed by the 66th Texas Legislature.

1.8 EXISTING UTILITIES

- A. Locations and elevations of various utilities included with the scope of this work have been obtained from the most reliable sources available and should serve as a general guide without guarantee to accuracy. The Contractor shall examine the Site and verify to his own satisfaction the locations and elevation of all utilities and availability of utilities and services required. The Contractor shall inform himself as to their relation to the work and the submission of bids shall be deemed as evidence thereof. The Contractor shall repair at his own expense, and to the satisfaction of the Owner, for damage to any utility shown or not shown on the plans.
- B. Should utilities not shown on the plans be found during excavations, Contractor shall promptly notify the Owner for instructions as to further action.
- C. Contractor shall make necessary adjustments in the layout as may be required to connect to existing stub-outs, should such stub-outs not be located exactly as shown and as may be required to work around existing work, at no increase in cost to the Owner. All such work will be recorded on record drawings and turned over to the Owner prior to final acceptance.

1.9 RECORD DRAWINGS

- A. Record dimensioned locations and depths for each of the following:
 - 1. Point of connection.
 - 2. Sprinkler pressure line routing (provide dimensions for each 100 lineal feet (maximum) along each routing, and for each change in directions).
 - 3. Gate valves.
 - 4. Sprinkler control valves (buried only).
 - 5. Control wire routing.
 - 6. Other related items as may be directed by the Landscape Owner's representative.
- B. Locate all dimensions from two permanent points (buildings, monuments, sidewalks, curbs, or pavements).
- C. Record all changes which are made from the Contract drawings, including changes in the pressure and non-pressure lines.
- D. Record all required information on a set of blackline prints of the Contract drawings. Do not use these prints for any other purpose.
- E. Maintain information daily. Keep Contract drawings at the Worksite at all times and available for review by the Owner's representative.
- F. When record drawings have been approved by the Owner's Representative, transfer all information to a set of reproducible digital files.

1.10 CONTROLLER CHARTS

- A. Do not prepare charts until record drawings have been approved by the Owner's representative.
- B. Provide one controller chart for each automatic controller installed.
 - 1. Chart may be a reproduction of the record drawing, if the scale permits fitting within the controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
 - 2. Chart shall be blackline print of the actual system, showing the area covered by that controller.
- C. Identify the area of coverage of each remote-control valve, using a distinctly different pastel color, drawn over the entire area of coverage.
- D. Following approval of charts by the Owner's representative, they shall be hermetically sealed between two layers of 20 mil. thick plastic sheet.
- E. Charts must be completed and approved prior to final acceptance of the irrigation system.

1.11 OPERATING AND MAINTENANCE MANUALS

- A. Provide individual bound manuals detailing operating and maintenance requirements for irrigation systems.
- B. Manuals shall be delivered to the Owner's representative for review and approval no later than 10 days prior to completion of work. Revise manual as required.
- C. Provide descriptions of all installed materials and systems in sufficient detail to permit maintenance personnel to understand, operate, and maintain the equipment.
- D. Provide the following in each manual:
 - 1. Index sheet, stating Irrigation Contractor's name, address, telephone number, and name of person to contact.
 - 2. Duration of guarantee period.
 - 3. Equipment list providing the following for each item:
 - a. Manufacturer's name.
 - b. Make and model number.
 - c. Name and address of local manufacturer's representative.
 - d. Spare parts list in detail.
 - e. Detailed operating and maintenance instructions of major equipment.
 - 4. Recommended programs for watering by season.

1.12 CHECKLIST

- A. Provide a signed and dated checklist and deliver to the Owner's Representative prior to final acceptance of the work.
- B. Use the following format:
 - 1. Plumbing permits: if none required, so note.
 - 2. Material approvals: approved by and date.
 - 3. Pressure line tests: by whom and date.

4. Record Drawings: received by and date.
5. Controller charts: received by and date.
6. Materials furnished: received by and date.
7. Operation and maintenance manuals: received by and date.
8. System and equipment operation instructions: received by and date.
9. Manufacturer's warranties if required: received by and date.
10. Written guarantee: received by and date.
11. Lowering of heads in lawn areas: if incomplete, so state.

1.13 WATER FOR TESTING

- A. Unless noted otherwise on the plans or elsewhere, furnish all water necessary for testing, flushing, and jetting.

1.14 BORINGS, SLEEVES AND ELECTRICAL CONDUITS

- A. Sleeves and electrical conduits are the responsibility of the Irrigation Contractor to install prior to paving or related construction and should be installed as noted on the drawings and specifications. Contractors shall be responsible for locating all sleeves and conduits at no additional cost to the Authority. Borings under existing paving will be required where noted on the drawings and shall be provided at no additional cost to the Owner. Borings shall be a minimum of 18-inch depth and new pipes shall be incased in Class 200 sleeves.

1.15 SPARE PARTS

- A. The Contractor shall supply the Owner with five spray heads, one for each head type designated on the plan. The Contractor shall supply one additional key and hose swivel for the quick coupler.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. General: Use only new materials of types and descriptions noted on the drawings and in currently use at the project site. Mix of manufacturers is not permissible.

2.2 MATERIALS

- A. Backfill Material: Existing site material, if approved by Client's Representative, shall be used for backfill material. Backfill material shall be free from organic materials, large clods of earth or rocks larger than one (1) inch diameter, trash, debris, rubbish, broken cement, asphalt material or other objectionable substances.

2.3 MANUFACTURED UNITS

- A. Pipe, Tubes And Fittings

1. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
 2. Hard Copper Tube: **ASTM B88, Type K**, water tube, drawn temper.
 - a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - b. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
 - c. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
 3. PVC Pipe: ASTM D1785, PVC 1120 compound, **Schedules 40 and 80**.
 - a. PVC Socket Fittings: ASTM D2466, **Schedules 40 and 80**.
 - b. PVC Threaded Fittings: ASTM D2464, Schedule 80.
 - c. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
- B. Piping Joining Materials:
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick unless otherwise indicated; full-face or ring type unless otherwise indicated.
 2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
 4. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
 5. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 6. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Sleeving
1. Sleeves for Control Wire and Water Lines: PVC Class 200 pipe.
- E. Gate Valves
1. Gate Valves 2 1/2" and smaller shall be bronze construction with operating wheel and screwed connections. Install in 10" diameter heavy duty plastic valve box. Use concrete valve box in paved or hardscape areas including gravel and decomposed granite areas.
 2. Gate Valves 3" through 10" shall be epoxy coated cast iron with operating nut (2" square) and "O" ring connections for PVC plastic pipe and resilient seat. Install in appropriate valve box.
 - a. Roadway locations: Cast iron valve box complete with PVC sleeves. Cast iron cover.
 - b. Landscaped areas: Christy F8 box or equal with F8D reinforced concrete lid marked "GV". Perimeter Cap and Lid to have polypropylene or polyethylene cap.
 - c. Concrete or sidewalk areas: Christy G5 traffic box or equal with G5C traffic rated cast iron lid marked "GV". Box to have cast iron perimeter ring cap and lid seat.
- F. Quick Coupler Valves
1. Quick-coupling valves shall have a brass or bronze two-piece body designed for a working or static pressure of 150 psi operable with quick coupler key. Quick coupling keys shall be of a type designed to operate quick coupling valve.

G. Remote Control Valves

1. All remote-control valves shall be the type and size shown on the drawings.

H. Valve Boxes

1. 2-½" and smaller gate valves and quick couplers in lawn areas: Use heavy duty ten inch diameter (10"Ø) round plastic valve box with bolt-down lid for all gate valves and quick couplers; example Brooks #910 or approved equal. Color to be black.
2. Remote Control Valves in lawn areas: Use heavy duty plastic valve box with bolt-down lid for remote control valves; No smaller than Carson #1419 or approved equal. One valve per box. Color to be black. Size box to accommodate remote control valve, ball valve, and unions to facilitate maintenance
3. Valve boxes in paving: Use precast polymer concrete Oldcastle with bolt-down lid for remote control valves; No smaller than Oldcastle Polymer #1118-12 or approved equal. One valve per box. Size box to accommodate remote control valve, ball valve, and unions to facilitate maintenance

I. Controller

1. Multiple start time programming.
2. Minimum 3 cycles preprogram capability.
3. Operation information including recommended monthly and seasonal schedules, water budgets based on gallons used or landscape planting for year one and year three, with the irrigation plan and documentation.
4. Independent rain and freeze shut-off device.
5. Locking capability, mounted per details
6. System shall be grounded per manufacturer's recommendations Remote Control Wire:
 - a. Connections between the automatic controllers and the remote-control valves shall be made with direct burial copper wire AWG-U.F. 600 volt. Pilot wires shall be different color wire for each automatic controller. Common wires shall be white with a different color stripe for each controller. Install in accordance with automatic controller manufacturer's specifications and wire chart. In no case, shall wire size be less than, AWG #14 U.F.
 - b. All wire shall be installed according to local electrical codes and must bear UL approved (Type UF) for direct underground burial.

J. (Backflow Device)

1. Per City Of Arlington Detail and Specifications

K. Pressure Regulating Device

1. Install at Point of Connection and at section valve as necessary so that the irrigation components operate within the manufacturers' recommended operating pressure.

L. Sprinkler Heads

1. All sprinkler heads shall be of the same size, type, and deliver the same rate of precipitation with the radius of throw, pressure, and discharge as listed on the drawings.

2. Spray heads shall have a screw adjustment for radius.
3. Riser units shall be fabricated in accordance with the details.
4. Rotors to be gear driven, on stainless steel risers.
5. Head to include screens and pressure regulating device where require.
6. Provide heads that prevent downpipe draining of system
7. Rotors and Pop Up Heads to have wiper seals
8. Rotors and Pop Up Heads to have positive retraction
9. Part circle rotors to have memory adjustment capability
10. Bubblers – per plan

M. Valve Manifold and Riser Fittings

1. Connect between main lines and remote-control valves shall be of schedule 80 PVC (threaded both ends) nipples and fittings.
2. Ball Valves: Apollo bronze body manual ball valves with stainless steel plastic covered handle (150 p.s.i. rated) with NPT connections.
3. Control Wire Splicing Materials: Aqua Splice Heat Shrink Splice as manufactured by R Raychem, DBY as manufactured by 3M, or equal.
4. Trench Backfill Under On-Grade Paving: Pit run sand or fine aggregate with at least 90 percent passing number 4 sieve and no more than 10 percent passing number 200 sieve.
5. Trench Backfill at On-Structure Planters: Soil mix from planters.
6. Conduit for Control Wire: Schedule 40 PVC.

N. Drip Irrigation Tubing

1. ASTM D2287, maximum inside diameter (id) of 1/2-inch, vinyl plastic extruded from non-rigid chloride, integrally algae-resistant, homogeneous throughout, smooth inside and outside, free from foreign materials, cracks, serrations, blisters and other effects. Provide compression fittings.

O. Drip Head Accessories

1. Strainer
 - a. Provide strainer at inlet to each drip control valve assembly. Provide polyester fabric screen attached to a PVC frame having the equivalent of 200 mesh filtration capacity. Compact "Y" body and cap configuration. Incorporate flush valves within strainer to clean screen without disassembling unit.
2. Tubing Stakes
 - a. Plastic, plastic coated steel, or other non-corrosive strong material to secure tubing.
3. Line Flushing Valve
 - a. Construct of PVC with maximum flow rate of 15 gpm with minimum flushing water volume of one gallon at a minimum 4 psi to a maximum 25 psi at a point of discharge.

PART 3 -- EXECUTION

3.1 INSTALLATION, GENERAL

- A. Design Pressure: This irrigation system has been designed to operate with a minimum static inlet water pressure as indicated on the drawings. The Contractor shall take a pressure reading prior to beginning construction. If the pressure reading is 5% less than above, the Contractor shall notify the Owner's Representative.
- B. Contractor Responsibility: The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in equipment usage, area dimensions or water pressure exist that might not have been considered by the Owner's Representative. Such obstructions or differences shall be brought to the attention of the Owner's Representative in writing. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.
- C. Staking: Before installation is started, place a stake or flag where each sprinkler is to be located, in accordance with drawing. Staking shall be approved by the Landscape Owner's representative before proceeding.
- D. Piping Layout: Piping layout is diagrammatic. Route piping around existing trees and root zones in such a manner as to avoid damage to plantings. Do not dig within the ball of newly planted trees or shrubs.
- E. In areas where trees are present, trenches will be adjusted on site to provide a minimum clearance of four times the trunk diameter of the tree (at its base) between any tree and any trench.
- F. All material and equipment shall be delivered to the Worksite in unbroken reels, cartons or other packaging to demonstrate that such material is new and of a quality and grade in keeping with the intent of these Specifications.

3.2 EXCAVATION AND TRENCHING

- A. The Contractor shall perform all excavation to the depth indicated in these Specifications and Contract drawings. The banks of trenches shall be kept as nearly vertical as practicable. Trenches shall be wide enough to allow a minimum of 4" between parallel pipelines or electrical wiring. Where rock excavation is required, or where stones are encountered in the bottom of the trench that would create a concentrated pressure on the pipe, the rock or stones shall be removed to a depth of six (6) inches minimum below the trench depth indicated. The over depth rock excavation and all excess trench excavation shall be backfilled with loose, moist earth or sand, thoroughly tamped. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the trench bottom, such shall be removed to a depth and length required, and the trench backfilled to trench bottom grade as hereinafter specified, with course sand, fine gravel or other suitable material.
- B. Bottom of trench grade shall be continued past ground surface deviations to avoid air pockets and low collection points in the line. The minimum cover specifications shall govern regardless of variations in ground surface profile and the occasional deeper

excavation required at banks and other field conditions. Excavation shall be such that a uniform trench grade variation will occur in all cases where variations are necessary.

- C. Trench excavation shall comprise the satisfactory removal and disposition of all materials and shall include all shoring and sheeting required to protect the excavation and to safeguard employees.
- D. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance back from edge of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted as directed by the Owner's Representative. When excavated material is of a rocky nature and the topsoil or any other layer of excavated material is suitable for pipe bedding and backfill in the vicinity of the pipe, such material shall be separately stockpiled for use in such bedding and pipe backfill operations, unless satisfactory imported material is used.
- E. All excavations and backfill shall be unclassified and covered in the basic bid. No additional compensation will be allowed for rock encountered.
- F. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations to their original conditions in a manner acceptable to the Owner's Representative.

3.3 PIPE INSTALLATION

- A. Sprinkler Mains: Sprinkler mains are that portion of piping from water source to electric valves. This portion of piping is subject to surges since it is a closed portion of the sprinkler system. Sprinkler mains shall be installed in a trench with a minimum of 18 inches of cover.
- B. Lateral Piping: Lateral piping is that portion of piping from electrical valve to sprinkler heads. This portion of piping is not subject to surges since it is an "open end" portion of the sprinkler system. Lateral piping shall be installed in a trench with a minimum of 12 inches of cover.

3.4 PVC PIPE AND FITTING ASSEMBLY

- A. Solvent: Use only solvent recommended by manufacturer to make solvent-welded joints following standards noted herein. Thoroughly clean pipe and fittings of dirt, dust, and moisture with an approved PVC primer before applying solvent.
- B. PVC to Metal Connection: Work metal connections first. Use a non-hardening pipe dope such as Permatex No. 2 or "Teflon" tape on threaded PVC to metal joints. Use only light wrench pressure.
- C. Threaded PVC Connections: Where required, use threaded PVC adapters into which pipe may be welded.
- D. Remove lumber, rubbish, and rocks from trenches. Provide firm, uniform bearing for entire length of each pipeline to prevent uneven settlement. Wedging or blocking of pipe will not be permitted. Remove foreign matter or dirt from inside of pipe before welding and keep piping clean during and after laying pipe.

- E. PVC pipe shall not be installed where there is water in the trench, nor shall PVC pipe be laid when temperature is 40 deg. F or below or when rain is imminent. PVC pipe will expand and contract as the temperature changes. Therefore, pipe shall be snaked from side to side of trench bottom to allow for expansion and contraction.

3.5 INSTALLATION OF MAINLINE COMPONENTS

- A. Backflow Preventer: As presented in the installation details, per manufacturer's instructions.
- B. Master Valve/Flow Sensor Assembly: As presented in the installation details, per manufacturer's instructions. Install where indicated in the irrigation plans.

3.6 HYDROSTATIC TESTS

- A. Pressure Test: After the pipe is laid, the joints completed, and the trench partially backfilled, leaving the joints exposed for examination, the newly laid piping or any valved Section of main pressure line piping shall, unless otherwise specified, be subjected for four hours to a hydrostatic pressure test of normal city water pressure. Each valve shall be opened and closed during the test. Enclosed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade, as necessary. Cracked or defective pipe, joints, fittings, or valves discovered in consequence of this pressure test shall be repeated until the test results are satisfactory. All replacement and repair shall be at Contractor's cost.

3.7 CONTROL WIRE INSTALLATION

- A. All control wire less than 500 feet in length shall be continuous without splices or joints from the controller to the valves. Connections to the electric valves shall be made within 18 inches of the valve using connectors specified in this Section, unless otherwise approved by the Owner's Representative in writing.
- B. All control wires shall be installed at least 18 inches deep. Contractor shall obtain the Owner's Representative's approval for wire routing when installed in a separate ditch. Control wires may be installed in a common ditch with piping. However, wires must be installed a minimum of 4 inches below or to one side of piping.
- C. All wire passing under existing or future paving, sidewalk, construction, etc., shall be encased in PVC Schedule 40 conduit extending at least 2 feet beyond edges of paving, sidewalks, or construction.

3.8 POP-UP SPRAY, BUBBLER HEADS

- A. Provide heads and nozzles as specified and install in locations as shown on the Contract Drawings.
- B. Pop-up spray heads shall be installed on "flex" PVC as detailed on the Contract drawings. Rotary heads shall be installed on a double swing joint connected to the lateral pipe as detailed on the drawings.
- C. Heads shall be installed with underside of flange flush with the finished grade.

- D. Contractor will be required to adjust heads as necessary after establishment of grass or other plant material.

3.9 VALVE AND VALVE BOX PLACEMENT

- A. All manual, electric, and quick coupling valves shall be in boxes as specified in this Section and shall be set with a minimum of six (6) inches of space between their top surface and the bottom of the valve box. The base of the box shall be filled with pea gravel as
- B. Valves shall be fully opened and fully closed to ensure that all parts are in operating condition.
- C. Valve boxes shall be set plumb, vertical, and concentric with the valve stem.
- D. Any valve box which has moved from this required position so as to prevent the use of the operating wheel of the valve shall be reset by the Contractor at his own expense.

3.10 ELECTRIC REMOTE-CONTROL VALVES

- A. Remote control valves shall be located and sized as shown on the plans. All electrical connections shall be made when the weather is dry with connection kits as specified this Section in strict accordance with manufacturer's recommended procedures. All remote-control valves shall be installed in a horizontal position, in accordance to the manufacturer's published installation instructions.
- B. It shall be the responsibility of the Contractor to furnish and install the proper size wire on each of the low voltage circuits from the master control center to the various electric remote-control valves.
- C. Consideration shall be given to each circuit for allowance of voltage drop and economy consistent with accepted practices of electrical installation. Under no circumstances shall the voltage of any branch circuit be reduced more than proper due to length of run exceeding the maximum allowable for the wire size used.

3.11 BACKFILL AND COMPACTION

- A. After system is operating and required tests and inspections have been made, the trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, gravel, soft shale, or other approved materials, free from large clods of earth or stone. Rock, broken concrete, or pavement, and large boulders shall not be used as backfill material. The backfill shall be thoroughly compacted and evened with the adjacent soil level.
- B. Compact trenches in areas to be planted by thoroughly flooding the backfill. Compact all other areas by flooding or hand tamping. The jetting process may be used in areas when flooding.
- C. Backfill for all trenches, regardless of the type of pipe covered, shall be compacted to a minimum of 90% density.

- D. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for compaction, then refilled and compacted with the surface restored to the required grade and left in a completed surface condition as described above.
- E. Specifically tamp backfill under heads and around the flange of heads for one foot (1') by a suitable means after trench backfill has dried from flooding to prevent heads loosening in the ground.

3.12 FINAL ADJUSTMENT

- A. After installation has been completed, make final adjustment of sprinkler system prior to Owner's Representative's final inspection.
- B. Completely flush system to remove debris from lines by removing nozzle from heads on ends of lines and turning on system.
- C. Check sprinklers for proper operation and proper alignment for direction of throw.
- D. Check each Section for operating pressure and balance to other Sections by use of flow adjustment on top of each valve.
- E. Check nozzle ling for proper coverage. Prevailing wind conditions may indicate that arc or angle of spray should be other than as shown on drawings. In this case, change nozzles to provide correct coverage and furnish record data to Owner's Representative with each change.
- F. After system is thoroughly flushed and ready for operation, each Section of sprinklers shall be adjusted to control pressure at heads. Use the following method, one Section at a time:
 - 1. Remove last head on Section and install a temporary riser above grade. Install tee with pressure gauge attached on top of riser and re-install head with nipple onto tee.
 - 2. Correct operating pressure at last head of each Section as follows: Spray Heads - 30-35 psi.
 - 3. After replacing head, at grade, tamp thoroughly around head.
 - 4. Drip zone valve pressure regulating devices shall be set at not to exceed 40 psi.

3.13 CLEAN-UP

- A. The Worksite shall be thoroughly cleaned of all waste materials and all unused or salvaged materials, equipment, tools, etc.
- B. After completion of the work, areas disturbed shall be leveled and the Worksite shall be raked clean and left in an orderly condition.

END OF SECTION

SECTION 32 91 13

PLANTING SOILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Documents, as listed on the Table of Contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made a part of this Section.
- B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the Work of this trade.

1.2 SUMMARY OF WORK

- A. The Work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods necessary to supply and place planting soils as indicated on the Contract Documents and as specified. Supplying and placement of planting soils shall include, but not be limited to:
 - 1. Supplying soil that meets the Specifications of this Section for all tree pits, shrub beds, planting beds, and lawn areas, including seeding or sodded areas.
 - 2. Sampling and testing of proposed soil by a qualified soils lab as specified in this Section.
 - 3. Modifying, screening, placing, spreading and grading of approved soil.
- B. The site for this project has no existing topsoil for reuse. For the purposes of this Section all references to "Planting Soil" shall mean providing and placing loam or topsoil (obtained from an off-site source) which has been modified to meet the requirements of this Section. The planting soil shall be placed on all sodded and seeded areas, as well as used for backfilling for planting pits for trees, shrubs, perennials, and groundcovers.

1.3 RELATED WORK IN OTHER SECTIONS

- A. The following items of related work are specified and included in other Sections of the Specifications:
 - 1. Section 329213 – Seeding
 - 2. Section 329300 – Planting

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. D 75 - Practice for Sampling Aggregates
 - 2. D 422 - Test Method for Particle-Size Analysis of Soils
 - 3. D698-00a - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)
 - 4. D1557 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10-lb Rammer and 18-in. Drop

- B. A.O.A.C.: Association of Official Agricultural Chemists.

1.5 SUBMITTALS

- A. At least 20 days prior to ordering materials, the Contractor shall submit to the Owners Representative samples, certifications, manufacturer's product data and certified test results for materials as specified below for approval. No materials shall be ordered or delivered until the required submittals have been reviewed and approved by the Owner's Representative. Delivered materials shall closely match the approved samples. The Owner's Representative reserves the right to reject on, or after delivery, any material that does not meet these Specifications.
- B. Testing of loam for planting soil mix shall be at the Contractor's expense. Contractor shall deliver all planting soil samples to testing laboratory via overnight courier and shall have the testing report sent directly to the Owner's Representative. Soil testing shall be done by a certified soils lab such as the Texas A&M Soils, Water and Forage Testing Laboratory, 2478 Texas A&M University, College Station, TX 77843-2478, email: www.soiltesting@tamu.edu, phone 979-845-4816. Perform all tests for gradation, organic content, soil chemistry and pH – **A&M labs specify Analysis Suite No 10**. Testing reports shall include the following tests and recommendations.
1. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System. Sieve analysis shall be by combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D 422 after destruction of organic matter by H₂O₂. To facilitate review and approval of sieve analysis, provide a computer-generated gradation curve.
 2. Percent of organics shall be determined by the loss on ignition of oven-dried samples. Test samples minus #10 material shall be oven-dried to a constant weight at a temperature of 450 degrees Fahrenheit.
 3. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, extractable Aluminum, Lead, Zinc, Cadmium, Copper, Soluble Salts, and pH and buffer pH. A Conductivity Meter shall be used to measure Soluble Salts in 1:2 soil/water (v/v). Except where otherwise noted, nutrient tests shall be for available nutrients.
 4. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies as necessary, and for additives necessary to accomplish the work as specified.
 - a. Peat Moss: Submit a one cubic foot sample and supplier's certification of contents.
 - b. Limestone: Submit supplier's certification that the limestone being supplied conforms to these Specifications.
 - c. Acidulant: Submit supplier's certification that the acidulant being supplied conforms to these Specifications.
 - d. Fertilizer : Submit product data of fertilizer and certificates showing composition and analysis.
 5. Submit fertilization rates for fertilizer product based upon soil testing, analysis, and recommendations as specified, performed and paid for in this Section, PLANTING SOILS.
 6. Submit the purchasing receipt showing the total quantity purchased for the project prior to installation.
 7. Gypsum: Submit manufacturer's product data and sample.

8. All additives needed to amend a specific soil in order to meet these Specifications.

1.6 EXAMINATION OF CONDITIONS

- A. The Contractor, and any sub-Contractor responsible for the execution of the Work of this Section, shall review the subgrades and verify that the subgrades have been excavated and prepared as required by this Section prior to proceeding with the spreading of the soil mix. Carefully review the requirements of this Section to understand the requirements of percolation testing, compaction, and absence of debris of the subgrade prior to spreading of the soil mix.

PART 2 - MATERIALS

2.1 LOAM - GENERAL

A. DEFINITIONS

1. The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

<u>Conventional Name</u>	<u>Retained on U.S. Sieve No.</u>	<u>Diameter (mm)</u>
Very coarse sand	#18	1 - 2
Coarse sand	#35	0.5 - 1
Medium sand	#60	0.25 - 0.5
Fine sand	#140	0.10 - 0.25
Very fine sand	#270	0.05 - 0.10
Silt	by hydrometer	0.002 - 0.05
Clay	by hydrometer Less than	0.002

2. Sandy loams shall conform to USDA Soil Taxonomy definitions and as follows: Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30 percent, and 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 percent and 52 percent sand.
 - a. Coarse sandy loam: 25 percent or more very coarse and coarse sand and less than 50 percent any other grade of sand.
 - b. Sandy loam: 30 percent or more very coarse, coarse and medium sand, but less than 25 percent very coarse sand, and less than 30 percent very fine or fine sand.
 - c. Fine sandy loam: 30 percent or more fine sand and less than 30 percent very fine sand or between 15 and 30 percent very coarse, coarse, and medium sand.

2.2 SOIL MIX

- A. The soil mix for planting trees, shrubs, groundcover, and for seeding and sodded areas shall be imported from an off-site source and be installed at a min of 3" depth for all seeded or sodded areas, and to depths shown on the Contract documents for trees, shrubs, and other plant materials. The soil mix shall be "sandy loam" determined by mechanical analysis (ASTM D 422) and based on the "USDA Classification System" and as defined in this Section. It shall be of uniform composition, without admixture of subsoil. It shall

be free of stones greater than one and one-quarter inches, lumps, plants and their roots, debris and other extraneous matter as determined by the Owner's Representative. Planting soil shall have the following grain size distribution for material passing the #10 sieve:

Millimeter	Percent Passing by Weight	
	Maximum	Minimum
2	-----	100
1	100	80
0.5	87	67
0.25	78	48
0.10	68	30
0.05	55	22
0.002	7	2

1. Maximum size for planting soil mix shall be one quarter inch largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.

2.3 SOIL ADDITIVES

- A. General: Soil additives shall be used to counteract soil deficiencies as recommended by the soils testing analysis.
- B. Acidulant for adjustment of loam pH shall be commercial grade flours of sulfur, ferrous sulfate, or aluminum sulfate that are unadulterated. Acidulants shall be delivered in unopened containers with the name of the manufacturer, material, analysis and net weight appearing on each container.
- C. Ground limestone for adjustment of loam pH shall contain not less than 85 percent of total carbonates and shall be ground to such fineness that 40 percent will pass through 100 mesh sieve and 95 percent will pass through a 20-mesh sieve. Contractor shall be aware of loam pH and the amount of lime needed to adjust pH to meet the requirements of the testing lab recommendations.
- D. Organic component of the manufactured loam shall be compost and peat moss used in equal proportions. Compost shall be a stable humus-like material produced from the aerobic decomposition of organic residues. The residues, if bio-solids, shall consist of compost meeting MA-DEP Type 1 requirement or approved equal. The residues shall be dark brown or black in color, with no visible free water or dust and no unpleasant odor, meeting the following criteria certified by the producer:
 1. Carbon-nitrogen ratio Minimum 10:1 maximum 25:1
 2. Stability CO₂ evolution test <10 mg CO₂ - C/g BVS/day
Or Dewar self-heating test <10 degrees C above room temp.
Or Woods End Laboratory's Compost Test Kit
 3. Organic content 40 percent minimum dry weight (Loss on Ignition; minus #10 Sieve, 430 degrees C)
 4. Particle size 90 percent passing 0.5 inch screen, 100 percent passing one-inch screen
 5. Inorganic debris 1 percent maximum (dry weight)

6. pH	minimum 5.5 - maximum 8.0
7. Soluble Salts	>2 and <4.0 mmhos/cm (ds/m)
8. Density	850-1,050 lb./cy

- E. Peat moss shall be composed of the partly decomposed stems and leaves of any of several species of sphagnum moss. It shall be free from wood, decomposed colloidal residue and other foreign matter. It shall have an acidity range of 3.3 pH to 5.5 pH, as determined in accordance with the methods of testing of A.O.A.C., latest edition. Its water absorbing ability shall be a minimum of 1,100% by weight on an oven-dry basis.
- F. Sand, as required for mixing with soil to meet Specification requirements shall be uniformly graded coarse sand consisting of clean, inert, rounded grains of quartz or other durable rock and free from loam or clay, surface coatings, mica, other deleterious materials with the following gradation.

<u>Millimeter</u>	<u>Percent Passing by Weight</u>	
	<u>Maximum</u>	<u>Minimum</u>
5	-----	100
2	100	80
1	86	58
0.5	50	18
0.25	24	7
0.10	0	10
0.05	0	4.5
0.002	0	0.3

1. The ratio of the particle size for 70% passing (D₇₀) to the particle size for 20% passing (D₂₀) shall be 4.0 or less. (D₇₀/D₂₀ < 4.0)
- G. Bone meal shall be fine ground, steam-cooked, packing house bone with a minimum analysis of 23 percent phosphoric acid and one percent nitrogen.
- H. Gypsum (CaSO₄ · 2H₂O) shall be agricultural grade, granular form.
- I. Gradation shall conform to the following:

<u>Sieve Designation</u>	<u>Percent Passing by Weight</u>
No. 8 (2.36 mm)	100
No. 16 (1.18 mm)	97
No. 30 (0.60 mm)	82
No. 50 (0.30 mm)	46
No. 100 (0.15 mm)	21

- J. Commercial fertilizer shall be a product complying with the State and United States fertilizer laws. Deliver fertilizer to the site in the original unopened containers bearing the manufacturer's certificate of compliance covering analysis and which shall be furnished to the Owner's Representative. Fertilizer shall contain not less than the percentages of weight of ingredients as recommended by the soil testing analysis.

PART 3 - EXECUTION

3.1 FILLING AND COMPACTION

- A. Subgrade shall be prepared for prior to spreading of planting soil mix.
- B. Perform percolation tests on existing subsoils, or placed fill, prior to placing and spreading planting soil mix:
 - 1. Perform percolation testing of subsoil in planting pits or placed fills to determine whether or not the subgrade will drain properly. Perform percolation tests as specified in this Section and for each lift of loam borrow.
 - 2. In the event that percolation testing indicates that the subsoil, placed fills has been over compacted and will not drain, the Contractor shall loosen up the top 6 inches of the subgrade to be planted by using a hand shovel and loosen to a density that will percolate as specified under the work of this Section.
- C. Confirm that the subgrade is at the proper elevation and that no further earthwork is required to bring the subgrade to proper elevations.
- D. The Contractor shall install planting soil mix in successive horizontal lifts no thicker than 12 inches in one lift in plant bed areas to the desired depth and compaction as described herein. The Contractor shall install the soil at a higher level to anticipate any reduction of soil volume due to compaction, settling, erosion, decomposition, and other similar processes during the warranty period.
- E. In addition to the range cited above, compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through the soil. The loam borrow in each lift should feel firm to the foot in all areas and make only slight heel prints.

3.2 FINE GRADING/PLACING OF PLANTING SOIL

- A. Planting soil shall be sampled and tested as specified to verify application and incorporation any required soil amendments to meet the recommendations of the soil testing analysis. It shall also be adjusted for pH and for organic content.
- B. Immediately prior to dumping and spreading planting soil for seeded or sodded areas, the subgrade shall be rototilled to depth of 4 inches to reduce construction compaction and to make sure planting soil bonds to subgrade, raked smooth, and cleaned of all stones greater than 1 inch and all debris or rubbish. Such material shall be removed from the site, not raked to the edges and buried. Notify the Owner's Representative that the subsoil has been prepared and cleaned and request his/her attendance on site to review and approve subgrade conditions prior to spreading the planting soil. The soil shall be weed free. If weeds occur after planting, the contractor shall be responsible to remove all weeds at no additional cost.
- C. Once the planting soil has been spread, sufficient grade stakes shall be set for checking the finished grades. Stakes must be set in the bottom of swales and at the top of slopes. Deviation from indicated elevations that are greater than one-tenth of a foot shall not be permitted. Connect contours and spot elevations with an even slope. Finish grades shall be smooth and continuous with no abrupt changes at the top or bottom of slopes.

- D. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional planting soil and the surface shall be re-graded and rolled until presenting a smooth and even finish corresponding to the required grades.
- E. The Contractor shall install planting soil in successive horizontal lifts no thicker than 2 feet in plant bed areas to the desired compaction as described herein. The Contractor shall install the soil at a higher level to anticipate any reduction of soil volume due to compaction, settling, erosion, decomposition, and other similar processes during the warranty period.
1. Compact planting soil to the required density as specified herein.
 2. Maximum dry density for planting soil shall be determined in accordance with ASTM D698. The following percentages of minimum to maximum dry densities shall be achieved for fill materials or prepared subgrades.
 3. In seeded and sodded areas, plant beds, and tree pits:

<u>Minimum</u>	<u>Maximum</u>
80%	85%
 4. The surface area of each lift shall be scarified by raking prior to placing the next lift.
- F. In addition to the range cited above, compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through the soil. The loam borrow in each lift should feel firm to the foot in all areas and make only slight heel prints. At completion of the planting soil installation, the soil should offer a firm, even resistance when a soil sampling tube is inserted from lift to lift. After the placement of each lift, perform percolation tests to determine if the soil has been over compacted. Perform the following percolation test procedure:
1. Dig a hole in the installed soil that is a minimum of 4 inches in diameter. Holes in 6-inch lift in turf areas shall be 4 inches deep. Holes in 2 foot lifts in plant beds shall be 8 inches deep. Do not penetrate through the lift being tested.
 2. Fill the hole with water and let it drain completely. Immediately refill the hole with water and measure the rate of fall in the water level.
 3. In the event that the water drains at a rate less than one inch per hour, till the soil to a depth required to break the over compaction.
 4. Perform a minimum of one soil percolation test per 10,000 square feet area of turf area and 2,500 square feet of tree and shrub planting area as directed by the Owner's Representative.
- G. Select equipment and otherwise phase the installation of the planting soil to ensure that heavy wheeled equipment does not travel over prepared subsoil, or already installed planting soil. Movement of tracked equipment over said soils will be reviewed and considered for approval by the Owner's Representative. If it is determined by the Contractor that wheeled equipment must travel over already installed soil, provide a written description of sequencing of work that ensures that compacted soil is loosened and un-compacted as the work progresses, or place 1 inch thick steel plate ballast (or equivalent ballast approved by the Owner's Representative) over the length and width of any travel way to cover loam borrow to protect it from compaction.
- H. Disturbed areas outside the limit of lawn work shall be graded smooth and spread with a minimum of 3 inches of planting soil to the finished grade.

- I. Contractor shall be responsible for maintaining all stockpiles of planting soil on the site until final placement.
- J. Any excess on-site soil shall be placed in areas as directed by the Owner's Representative, or if directed, removed from the site at no additional cost.

3.3 ACCEPTANCE

- A. Confirm that the final grade of the planting soil mix is at the proper finish grade elevations and to the depths shown on the Contract Documents. Adjust grade or depth as required to meet the contours and spot elevations noted on the Plans. Request the presence of the Owner's Representative to inspect final grade before planting, seeding or sodding. Do not proceed with the remaining Work of this Contract until the Owner's Representative has given his/her written approval of the final grades.

END OF SECTION

SECTION 32 92 13

SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the Work of this trade.

1.2 SUMMARY OF WORK

- A. The Work of this Section includes all labor, materials, and equipment necessary to complete the seeding of turfgrass which includes, but is not necessarily limited to the following:
 - 1. Furnishing and applying hydro-mulch seeding for seed mix.
 - 2. Watering
 - 3. Site clean up.
 - 4. Maintenance and guarantee

1.3 RELATED WORK

- A. The following items of related work are specified and included in other Sections of the Specifications:
 - 1. Section 329113 – Plantings Soils

1.4 QUALITY ASSURANCE:

- A. Seed: The Owner's Representative shall be furnished a signed copy of statement from vendor, certifying that each container of seed delivered is labeled in accordance with the Federal Seed Act and is at least equal to requirements previously specified. Seed analysis shall be furnished prior to commencement of planting operations. Each lot of seed may be re-sampled and re-tested in accordance with latest Rules and Regulations under the Federal Seed Act at the discretion of the Owner's Representative. If these tests reveal the seed to be below the specified pure live seed content, the Contractor shall be required to plant additional seed to compensate for the deficiency at no additional cost to the Owner. The seed retests will be conducted by the State Seed Laboratory. Allowance will be made for the actual pure live seed content of the specified grasses in determining the actual planting rate.

- B. Make written request for inspection after seeding operations have been completed. Such inspection is for the purpose of establishing the Maintenance Period. Submit written requests for inspections to the Owner's Representative at least seven (7) days prior to the inspection date.

1.5 SUBMITTALS

- A. Furnish required copies of manufacturer's literature, certifications, or laboratory analytical data for the following items:
 - 1. Seed Source. (Certification)
 - 2. Fiber Mulch. (Laboratory Analytical Data)
 - 3. Tank Mix Fertilizer. (Certification or Laboratory Analytical Data)
 - 4. Top-dress Fertilizer. (Certification analysis, and proof of purchase)
 - 5. Erosion Control (sample and manufacturer's information)

PART 2 - PRODUCTS

2.1 SEED FOR LAWN AREAS

- A. Seed for lawn areas shall be TIF 419 Bermuda Grass. All seed used shall be labeled in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act. All seed shall be furnished in sealed standard containers unless exception is granted in writing by the Owner's Representative. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable. Seed mixture shall be fresh, clean, new crop seed. Grass shall be of the previous year's crop and in no case shall the weed seed content exceed 0.25% by weight. The seed shall be furnished and delivered in the proportion specified below in new, clean, sealed and properly labeled containers. The minimum percentage by weight of pure live seed in each lot of seed shall be as follows and seed shall be planted at the rate per acre indicated under pure live seed required per acre.
- B. Seed for lawn areas to be planted at the rate of 3 lbs per 1000 sq. ft.

2.2 FERTILIZER FOR TANK MIX

- A. Fertilizer shall be a starter fertilizer as recommended by the seed company the seed is purchased from. The seed shall be uniform in composition, free-flowing, and suitable for application with approved equipment. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable State fertilizer laws, and bearing the name or trademark and warranty of the producer.

2.3 FIBER MULCH

- A. Fiber mulch, for use with the hydraulic application of turfgrass seed and fertilizer, shall consist of specially prepared mulch. It shall be processed in such a manner that it will not contain germination or growth inhibiting factors. It shall be dyed an appropriate color to allow visual metering of its application. The mulch shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like groundcover which readily absorbs water and allows infiltration to the underlying soil. Weight specifications from suppliers for all applications shall refer only to air dry weight of the fiber, a standard equivalent to eighteen (18%) percent moisture. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds and be marked by the manufacturer to show the dry weight content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements.

2.4 HERBICIDES, CHEMICALS AND INSECTICIDES

- A. Provide chemicals and insecticides as needed for fungus or pest control. All chemicals and insecticides shall be approved by the State of Texas Department of Food and Agriculture for the intended uses and application rates.
- B. Provide post emergent weed control throughout the maintenance period to ensure a germinated and mown turfgrass free of weeds.

2.5 WATER

- A. The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation. Water shall be free from oil, acid, alkali, salt, and other substances harmful to growth of plant material. The water source shall be subject to approval prior to use.

2.6 SLURRY MIX COMPONENTS PER ACRE:

- A. The slurry mix shall be composed of:
 - 1. Fiber Mulch 2,000 Pounds
 - 2. Grass Seed 10 lbs. per acre
 - 3. Fertilizer Starter Fertilizer – amount recommended by Seed Supplier

2.7 EROSION CONTROL MATTING

- A. Erosion control matting for covering hydromulch areas with slopes steeper than or equal to three to one (3:1) shall be a bonded fiber matrix. The bonded fiber matrix shall be a hydraulically applied product that upon drying shall adhere to the soil in the form of a continuous 100% coverage, biodegradable erosion control blanket. The bonded fiber matrix shall be comprised of long strand wood fibers held together by a bonding agent that, upon drying, becomes insoluble and non-dispersible.

- B. The bonded fiber matrix shall meet the following requirements. The binder shall not dissolve or disperse upon re-wetting. The matrix shall have no holes greater than 0.04 inch (1mm) in size. The matrix shall have no gaps between product and soil. The matrix shall have water-holding capacity of 1.2 gallons per pound of matrix (1000g/100g). The matrix shall have no germination or growth inhibiting factors and shall not form a water insensitive crust. The matrix shall be composed of materials that are 100% biodegradable and are beneficial to plant growth.

PART 3 - EXECUTION

3.1 HYDROMULCH SEEDING ON PREPARED FINISHED GRADE:

- A. Bed Preparation: Immediately after the soils have been placed per Section: 329113, Planting Soils, and the finished grades have been approved, begin hydro-seeding operation to reduce excessive weed growth.
- B. Special Mulching Equipment and Procedures: Hydraulic equipment used for the application of fertilizer, seed, and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing up to forty (40) pounds of fiber plus a combined total of seventy (70) pounds of fertilizer solids for each one hundred (100) gallons of water. See mix components mix ration herein this Section. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which provide even distribution of the slurry on the slopes to be seeded. The slurry tank shall have a minimum capacity of eight hundred (800) gallons and shall be mounted on a traveling unit which may be either self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution without waste. The Owner's Representative may authorize equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.
- C. Mixing: Care shall be taken that the slurry preparation takes place on the site of the work. The slurry preparation should begin by adding water to the tank when the engine is at half throttle. When the water level has reached the height of the agitator shaft, good recirculation shall be established and seed shall be added. Fertilizer shall then be added, followed by wood pulp mulch. The wood pulp mulch shall only be added to the mixture after the seed and when the tank is at least one-third filled with water. The engine throttle shall be opened to full speed when the tank is half filled with water. All the wood pulp mulch shall be added by the time the tank is two-thirds to three-fourths full. Spraying shall commence immediately when the tank is full. The operator shall spray the area with a uniform, visible coat by using the green color of the wood pulp as a guide.
- D. Application:
 - 1. Contractor shall obtain approval of hydro-mulch area preparation from the Owner's Representative prior to application.

2. Operators of hydro-mulching equipment shall be thoroughly experienced in this type of application. Apply specified slurry mix in a motion to form a uniform mat at specified rate.
 3. Keep hydro-mulch within areas designated and keep from contact with other plant material.
 4. Slurry mixture which has not been applied within four (4) hours of mixing shall not be used and shall be removed from the site.
 5. After application, the Contractor shall not operate any equipment over the covered area.
 6. Immediately after application, thoroughly wash off any plant material, planting areas, or paved areas not intended to receive slurry mix. Keep all paved and planting areas clean during maintenance operations.
 7. Refer also to the maintenance portion of this Section.
- E. Unseeded Areas: If, in the opinion of the Owner's Representative, unplanted skips, and areas that are noted after hydro-mulching that have been missed, the Contractor shall be required to seed the unplanted areas with the seed mix that was to have been planted at no additional cost to the Owner.
- F. Limit of grading and earthwork shall be limit of seeding unless otherwise indicated on the Contract Documents. All seeded areas disturbed outside the limit of seeding shall be prepared and seeded as specified herein at no additional cost.
- G. The season for seeding shall be from April 1 to May 1. No seeding shall be done outside this time period without approval by the Owner's Representative and recommendation of the seed supplier. The actual planting of seed shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and by accepted practice in this locality. To prevent loss of soil via water and wind erosion, and to prevent the flow of sediment, fertilizer, and pesticides onto roadways, sidewalks, and into catch basins, seed loam areas within 5 days of spreading the loam.
- H. Seed only when the bed is in a friable condition, not muddy or hard.

3.2 EROSION CONTROL MATTING

- A. Erosion control matting of heavy jute mesh shall be installed immediately after hydro-seeding and hydro-mulching in the areas designated on the Contract Documents, on slopes three to one (3:1) or steeper, within surface drainage swales, and around surface drains. Matting installation shall follow written acceptance of fine grading by Owner's Representative.
- B. Matting shall be installed perpendicular to slopes, and shall extend at least 3 feet beyond slope crest. Fibers shall be placed in contact with the soil for the entire length of the mat. Provide check slot at top of slope and anchor slot at bottom of slope where indicated.
- C. Roll out the matting perpendicular to the slope. Do not stretch the fabric. In drainage swales, center the fabric along the flow line. Install the matting in a check slot at the top and bottom of the slope of the area to be covered. Check slots shall be 6 inches deep and 6 inches wide. Fabric shall extend down one wall of the check slot and across the full

width of the base. Overlap edges of matting rolls 4 inches minimum and overlap the ends 18 inches at a minimum.

- D. Install staples in check slots, edges, center and ends of rolls by driving specified steel staples 2 feet on center over the entire area to be covered, except at check slots and ends of rolls, where staples shall be placed 6 inches on center.
- E. Fill check slots with loam and tamp firmly.
- F. Following matting installation, roll the entire area with a smooth drum roller weighing between 50 and 75 pounds per linear foot of roller. The finished installation of matting shall be firmly in contact with the soil and provide a smooth, finished appearance free from lumps or depressions.

3.2 INSPECTIONS:

- A. Make written request for inspection prior to seeding and after areas have been seeded.
- B. Submit requests for inspections to Owner's Representative at least two (2) days prior to the anticipated inspection date.

3.3 FINAL ACCEPTANCE:

- A. The seeded areas will be reviewed and accepted by the Owner's Representative upon Final Completion of the Work, but exclusive of re-application under the Guarantee Period.
- B. Final Acceptance of establishment shall be ninety five (95%) percent uniform coverage of seeded areas. No bare spots of greater than three (3) inches will be accepted.
- C. If seeded areas are deficient, the Contractor's responsibility for maintenance of all seeded areas shall be extended until deficiencies are corrected. Seeded areas to be corrected shall be prepared and re-seeded in accordance with the requirements of this Section.
- D. Owner's Representative's inspection shall determine whether maintenance shall continue in any part.

3.4 CLEAN UP

- A. Keep all areas of work clean, neat, and orderly at all times. Keep all paved areas clean during seeding installation operations. Clean up and remove all deleterious materials and debris from the entire work area prior to Final Acceptance to the satisfaction of Owner's Representative.

END OF SECTION

SECTION 32 93 00

PLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Documents, as listed on the Table of Contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made a part of this Section.
- B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the Work of this trade.

1.2 SUMMARY OF WORK

- A. The Work of this Section consists of providing all labor, equipment, materials, incidental Work, and construction methods necessary to perform all planting Work and related items as indicated on the Contract Documents and as specified in this Section and includes, but is not limited to, the following:
 - 1. Planting trees, shrubs, and ground cover
 - 2. Planting maintenance.
 - 3. A one-year guarantee period for all plants.
 - 4. Providing and placing planting soil mix.
 - 5. Tree Staking

1.3 RELATED WORK IN OTHER SECTIONS

- A. The following items of related Work are specified and included in other Sections of the Specifications:
 - 1. Section 329113 – Planting Soils

1.4 REFERENCES

- A. The following standards shall apply to the Work of this Section.
 - 1. Hortus III, 1976, L. H. Bailey Hortorium.
 - 2. Tree and Shrub Transplanting Manual, E.B. Himelick, 1991, International Society of Arboriculture.
 - 3. American National Standards Institute (ANSI): Z60.1 Nursery Stock
 - 4. American Standard for Nursery Stock, latest edition, published by American Association of Nurserymen, (AAN).

1.5 SUBMITTALS

- A. At least 30 days prior to the first day of the planting season described in this Section: PLANTING, submit to the Owner's Representative proof of certification of Foreman or Crew Leader as Certified Landscape Professional or Certified Horticulturist.

- B. At least 30 days prior to ordering materials, the Contractor shall submit to the Owner's Representative, samples, certifications, manufacturer's product data and certified test results for materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and approved by the Owner's Representative. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The Owner's Representative reserves the right to reject, on or after delivery, any material which does not meet these Specifications.
- C. Material Sampling and Testing:
 - 1. Planting Mulch: Submit a one cubic foot sample.
 - 2. Antidesiccant: Submit manufacturer's product data.
 - 3. Peat: Submit a one cubic foot sample and manufacturer's certification of contents.
 - 4. Mycorrhizal Fungal Inoculant:
 - a. Submit manufacturer's product data certifying that inoculant being supplied conforms to these Specifications.
 - b. Submit the purchasing receipt showing the total quantity purchased for the Project prior to installation.
 - c. Submit empty packets of fungal spore inoculant to the Owner's Representative for verification of use.

1.6 EXAMINATION OF CONDITIONS

- A. All areas to be planted shall be inspected by the Contractor before starting Work and any defects such as incorrect grading or inadequate drainage shall be reported to the Owner's Representative prior to beginning this Work.
- B. The Contractor shall be solely responsible for judging the full extent of Work requirements involved, including but not limited to the potential need for storing and maintaining plants temporarily and/or re-handling plants prior to final installation.
- C. All plants are the full responsibility of the Contractor between the time of digging at the nursery and final acceptance.

1.7 QUALITY ASSURANCE

- A. Qualification of Landscape Contractor: The Work of this Section: PLANTING, shall be performed by a landscape contracting firm which has successfully installed Work of a similar quality, schedule requirement, and construction detailing with a minimum of five years' experience. Proof of this experience shall be submitted to the Owner's Representative.
- B. Qualification of Arborist: All Work of pruning shall be performed by an arborist certified by the American Arborist Association or the International Society of Arboriculture and be licensed in Texas.
- C. Pest Control Applicator: Texas-Licensed landscape pest control applicator.
- D. Comply with American Joint Committee of Horticultural Nomenclature "Standardized Plant Names", American Association of Nurserymen, Inc. American Standard for Nursery Stock.

- E. Provide plant material as shown on Contract Documents. Plants shall be subject to inspection and approval by Owner's Representative at place of growth or upon delivery to site for conformity to specified requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Delivery:
 - 1. Pack plant material to protect against climatic, seasonal, and breakage injuries during transit.
Securely cover plant tops with tarpaulin or canvas to minimize wind-whipping and drying. Use antidesiccant upon approval of Owner's Representative.
Pack and ventilate to prevent sweating of plants during transit by rail. Ensure prompt delivery and careful handling to point of delivery at planting job site.
- B. Delivery:
 - 1. Fertilizer and Soil Amendments: Original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark and conformance to State law.
Plants: Provide legible identification labels. Minimum one plant of each species delivered to site shall have identification tag. Do not remove tag until after final inspection.
Prevent damage to root ball or desiccation of leaves.
Notify Owner's Representative 10 days in advance of delivery.
Soil Supplements: Original, unopened and unbroken packages.
 - 2. Inspect trees, shrubs, and ground cover plants for injury, insect infestation, and trees and shrubs for improper size and shape.
- C. Storage:
 - 1. Protect roots of plant material from drying or other possible injury with soil or acceptable material.
Store plant material in area which is shaded and protected from weather.
Maintain and protect plant material not to be planted immediately upon delivery in healthy, vigorous condition.
- D. Handling:
 - 1. Do not drop plants.
 - 2. Do not pick up container or balled plants by stem or trunks.
 - 3. Lift and handle balled plants from bottom of ball.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 95 degrees F (32 degrees C).
- B. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.10 WARRANTY

- A. Contractor shall maintain all landscape areas in a healthy, vigorous, and attractive growing condition for a period of 90 days after Final Acceptance.

- B. Warrant plant materials to be in healthy, vigorous, and attractive growing condition for period of 2 years after Final Acceptance.
- C. Replace plants which die, become diseased or unhealthy, or are otherwise found to be in poor condition, as determined by Owner's Representative.
- D. Warranty will not apply to damage or injury to plant materials caused by vandalism, vehicles, and storms.
- E. Replace plants within 15 days of written notification by Owner's Representative or Owner.

1.11 TREE TAGGING

- A. Contractor shall pay for all expenses related to the tagging of trees at the nursery.

PART 2 - MATERIALS

2.1 PLANTING SOIL MIX

- A. Planting soil mix shall be specified, provided, installed, and paid for under Section 329113 – Planting Soils.
- B. The planting soil mix shall be an approved loam borrow which has been pH adjusted according to particular planting applications and improved through the addition of organic matter as directed below. Planting loam shall conform to the following pH levels:
 1. For broad-leaved evergreens and plants of the Heath Family, Ericaceae, requiring an acid soil, planting soil mix shall have a true pH of 4.5 to 5.5. Planting soil mix shall be amended by the Contractor at his own expense to the proper pH range by mixing with sulfur as specified, provided, installed and paid for under Section: Planting Soils, of this Specification. Plants belonging to the Heath Family include but are not limited to the following genuses: Arctostaphylos, Calluna, Chamaedaphne, Enkianthus, Epigaea, Erica, Gaultheria, Gaylussacia, Kalmia, Oxydendron, Pieris, Rhododendron, Vaccinium, and Zenobia.
 2. Planting soil mix for general planting of non-acid loving plants shall have a true pH value of 6.0 to 6.5. Planting soil mix shall be amended by the Contractor at his own expense to the proper pH range by mixing with dolomitic limestone as specified, provided, installed and paid for under Section: Planting Soils.
 3. The amount of either sulfur or limestone required to adjust the planting soil mix to the proper pH range shall be approved by the Owner's Representative on the basis of soil tests as specified, provided, installed and paid for under the Section: Planting Soils.
 4. Planting soil mix for use in groundcover, perennial, and bulb planting shall consist of pH adjusted loam which has been thoroughly premixed with organic material in the proportions of one-part organic matter (humus or peat), with 5 parts of approved loam. Organic material shall be specified, provided, installed and paid for under Section: Planting Soils.

5. Presence of vegetative parts of Bermuda grass, Johnson grass, nut grass (*Cyperus rotundus*), and other hard to eradicate weeds or grass, will be cause for rejection of the topsoil.

2.2 SOIL ADDITIVES

- A. Soil additives to amend soil shall be specified, provided, installed and paid for under Section: 329113 - Planting Soils.

2.3 GRADES AND STANDARDS OF PLANTS

- A. The Contractor shall furnish all plants shown on the Contract Documents, as specified, and in quantities listed on the PLANT LIST. No substitutions will be permitted, without written approval by the Owner's Representative. All plants shall be nursery grown unless specifically authorized to be collected as noted on the PLANT LIST.
- B. All plants shall be typical of their species or variety and shall have a normal habit of growth and be legibly tagged with the proper name. Only plant stock grown within Hardiness Zones 1 through 7b, as established by the USDA Plant Hardiness Zone Map, latest edition, will be accepted.
- C. Plants shall be in accordance with ASNS Standards of the American Association of Nurserymen except as noted in this Section. Botanical plant names shall be in accordance with plant designations included in Hortus III.
- D. If, at any time during the performance of the Contract, any plant shows signs of graft incompatibility, as determined by the Owner's Representative, then the tree or shrub and all other similarly grafted plants of the same Genus/Species/Variety shall be rejected and removed from the site. Visual symptoms of graft incompatibility as cause for rejection include:
 1. Development of over-growths by rootstock or scion resulting in the development of shoulders or inverted shoulders.
 2. Suckering of the rootstock combined with poor growth or dieback of scion.
 3. Any mechanical weakness between scion and rootstock.
 4. Any marked difference in bark pattern and structure between scion and rootstock.
 5. Size and shape of plants shall correspond with that normally expected for species and variety of commercially available nursery stock or as shown on Drawings. Overall shape and minimum acceptable size of plants measured before pruning with branches in normal position shall conform with AAN standards. Plants larger in size than specified may be used with approval of Owner's Representative, at no additional cost to Owner. If use of larger plants is approved, ball of earth or spread of roots for each plant will be increased proportionately.
 6. Plant material shall be true to botanical and common name and variety.
- E. All deciduous trees shall meet the following standards:
 1. Trees shall have a single, straight trunk, well formed, and sturdy. No part of the trunk shall be conspicuously crooked as compared with normal trees of the same variety. Root systems shall be vigorous and fibrous, and not root or pot bound.
 2. Trees with multiple leaders shall conform to all standards noted in this Section for single leader trees and shall be accepted only as noted on the PLANT LIST.

3. All pruning wounds shall show vigorous bark on all edges at the time of harvest. Trees shall be free from all signs of pest and disease damage. The trunk shall be free from sun scald, frost cracks, and wounds resulting from abrasions, fire, animal damage, or other causes.
 4. Pruning scars within the crown of any tree shall be clean cut and shall leave no protrusion beyond the branch collar.
 5. All trees shall have healthy, vigorous leaves or needles of normal size, color, shape, and texture for the particular species and variety.
 6. Deciduous shade trees and deciduous flowering trees shall have fall color typical for their species and variety.
 7. Unless otherwise indicated on the PLANT LIST, the height and spread of deciduous shade trees shall be the minimum requirements.
 8. Take caliper measurements for deciduous trees 6 inches above ground level up to, and including, 4 inches caliper size and 12 inches above ground for larger sizes.
 9. No deciduous tree shall be pruned after the Owner's Representative has tagged the plant in the nursery except as directed by the Owner's Representative.
 10. Unless otherwise noted on the PLANT LIST, shade trees for use in paved areas shall have no branches lower than 6.5 feet from finish grade and no higher than 7.5 feet from finish grade. Flowering trees for use in areas away from pedestrian traffic shall have the first branch of their crowns no higher than 4 feet from finish grade.
 11. Branching of all deciduous trees shall be best quality representatives of the species, cultivar or variety with lateral branching around the entire trunk to form a symmetrical tree for 80 percent to 100 percent of the tree's outer perimeter. All branches on deciduous trees shall meet the trunk at angles no less than 30 degrees and no greater than 90 degrees from the vertical.
 12. All trees shall be container grown. Ball and Burlap not permitted.
- F. Evergreen trees shall meet the following standards:
1. The height of the evergreen trees (measured from the trunk flair at the natural ground line of the tree to the midpoint of the terminal leader) shall be not less than the minimum size designated on the PLANT LIST.
 2. No trees with double-leaders or twin-heads will be permitted.
 3. Evergreen trees shall be of specified height with spread in proportion to height, as designated in ASNS Standards, and shall be well-branched to the ground.
 4. All pruning wounds shall show vigorous bark on all edges at the time of harvest.
 5. Terminal and top whorl buds of all evergreen trees shall be in healthy and whole condition at the time of harvest.
 6. No evergreen tree shall be pruned after the Owner's Representative has tagged the tree in the nursery except as directed by the Owner's Representative.
 7. All trees shall have healthy, vigorous leaves or needles of normal size, color, shape, and texture for the particular species and variety.
 8. All trees shall be container grown. Ball and Burlap not permitted.
- G. All shrubs shall meet the following standards:
1. All shrubs shall be healthy and vigorous plants which are very well shaped, heavily branched, densely foliated, and true to form for the variety.
 2. Canes or Trunk(s) and Branches:
 - a. Well-formed and sturdy.
 - b. Branching shall be uniformly distributed close to the ground.

- c. Scars shall be free of rot and not exceed 1/4 the diameter of the wood beneath in greatest dimension unless completely healed (except pruning scars).
 - d. Pruning scars shall be clean cut and shall leave little or no protrusion from the trunk or branch.
 - e. Graft unions shall be completely healed.
 - f. No suckers or water sprouts.
 - g. Contain no dead wood.
 - h. Free of cracks, splits, or cambium peeling.
 - 3. No shrub with pest or mechanical damage will be accepted.
 - 4. Shrubs shall show no signs of frost or winter damage to the foliage. Foliage shall not be in a state of drought stress. Leaves or needles shall show no signs of wilt or desiccation due to weather stress at any season of the year.
- H. All ground cover plants and vines shall meet the following standards:
- 1. Ground cover plants and vines shall be of size, pot size, age, and condition listed in the PLANT LIST. When indicated on the PLANT LIST, the number of runners and the lengths of the runners of vines shall be minimums.
 - 2. Plants shall be healthy, free of insects, and diseases.

2.4 ROOT SYSTEMS FOR ALL PLANTS

- A. Each plant shall have an extensive, symmetrically balanced fibrous root system. Any root ball which shows signs of asymmetry, girdling, injury, or damage to the root system shall be rejected.
- B. Curling or spiraling of the roots along the walls of rigid containers will not be accepted. Curling, spiraling or girdling roots within balled and burlapped material will not be accepted.
- C. All parts of the fibrous root system of all plants shall be moist and fresh with a white color when washed of soil. When the plant is removed from the container, the visible root mass shall be healthy with white root tips. The root systems of all plants shall be free of disease, insect pests, eggs, or larvae.
- D. The diameter and depth of the balls of earth must encompass the fibrous and root feeding system necessary for the healthy recovery of the plant. Minimum root ball diameters and depths shall be in accordance with ASNS standards.
- E. No plants shall be loose in the container.
- F. Container grown plants which have roots growing out of the container will be rejected.

2.5 MYCORRHIZAL FUNGAL INOCULANT

- A. Mycorrhizal fungal inoculant shall be live spores packaged in plastic packets. At a minimum each packet of inoculant shall contain the following:
 - 1. Live spores of VA Endomycorrhizal fungi: Vesicular-Arbuscular mycorrhizae fungi, minimum of 8 species.
 - 2. Live spores of Ectomycorrhizal fungi: including *Pisolithus tinctorius*.

- B. Mycorrhizal fungal inoculant shall be manufactured by Plant Health Care Incorporated, 440 William Pitt Way, Pittsburgh, PA 15238, telephone: (800) 421-9051; Horticultural Alliance, 2946 Louise Street, Sarasota, FL 34237, (800) 628-6373; BioPlex Organics, 2213 Huber Drive, Manheim, PA 17545 (800) 441-3573, or approved equal.

2.6 MULCH

- A. Mulch shall be high quality, double-ground, premium cedar or hardwood mulch. It shall not be dyed red or black but shall be a natural brown color. Mulch shall have been aged for a minimum of six months and not longer than two years. Mulch shall be shredded to a uniform size; free of dirt, debris and foreign matter; with pieces no thicker than 1/4 in. Mulch must be free of stringy material or chunks over 3 inches in size and shall not contain, in the judgment of the Owner's Representative, an excess of fine particles. Submit sample for the Owner's Representative's approval.
- B. Geotextile fabric for weed control, if called for on the Contract Documents, shall be of woven, non-woven, spun-bonded, or needle-punched construction; composed of polyethylene, polypropylene, or polyester materials.
 - 1. Geotextile fabric shall have porosity of not greater than 5 percent open.
 - 2. Geotextile shall be Weed-X by Dalen Products, Knoxville, TN; DeWitt Pro 5 by the DeWitt Company, Sikeston, MO; or approved equal.

2.7 WATER

- A. The Contractor shall be responsible to furnish his own supply of water to the site at not additional cost to the Owner. Contractor shall be responsible to furnish adequate supplies at his own cost.

2.8 ANTIDESICCANTS

- A. Antidesiccants shall be emulsions or other materials which will provide a protective film over plant surfaces permeable enough to permit transpiration and specifically manufactured for that purpose. Manufacturer of antidesiccant shall be subject to the Owner's Representative's approval and shall be used only after approval by the Owner's Representative. Antidesiccant shall be delivered in containers of the manufacturer and shall be mixed and applied according to the Manufacturer's instructions.

PART 3 - EXECUTION

3.1 PLANTING

- A. Furnishing and planting of plant material shall include, but shall not be limited to, the digging of planting pits and plant beds, amendment of loam as required to produce planting soil mix, provision of soil additives required to adjust for pH requirements of specific plants, furnishing the plants as specified as well as the labor of planting, fertilizing, and maintenance.
- B. Prior to spreading of loam, subgrades shall have been tested to determine if they are too compact to drain water as specified, performed and paid for under the Work of Section: Planting Soils.

- C. The Contractor shall locate plant material sources and ensure that plants are shipped in timely fashion for installation.
- D. Contractor shall locate all existing underground utilities that are within 10 feet of the proposed planting pits and notify the Owner's Representative of any conflicts prior to digging plant pits.
- E. Seasons for Planting:
 - 1. Spring: March 15 through June 15
 - 2. Fall: September 1 through November 1
- F. Plant Material Inspection:
 - 1. At least one month prior to the expected planting date, the Contractor shall request that the Owner's Representative provide a representative to select and tag stock to be planted under this Section: PLANTING. The Contractor shall pay for the transportation, subsistence and overnight accommodations, if necessary, for the Owner's Representative's representative during the period of time required to select and tag the plant material.
 - 2. The Contractor shall be responsible to certify the availability of quality plants in specified sizes from his/her sources of supply prior to requesting that the Owner's Representative make plant source inspections. In the event that plants at the inspection location are found to be unavailable, insufficient size, or of unacceptable quality, the Contractor shall be liable to reimburse the Owner for all costs of the Owner's Representative's hourly services which are incurred during unproductive inspection trips.
 - 3. Unless specifically designated otherwise, a representative of the Contractor shall accompany the Owner's Representative on all plant material selection field trips.
 - 4. All trees for the Project shall be individually tagged for approval with the Owner's Representative's seals, and no trees shall be accepted for delivery to the site without such seals. Representative samples only of shrubs and ground cover plants may be tagged or marked for approval as an "Approved Typical Sample" and shipped to the site. Any shrub or groundcover plant that arrives at the construction site that does not meet the Approved Typical Sample will be rejected by the Owner's Representative.
 - 5. Plants to be inspected shall be in locations and conditions that allow direct and un-obscured inspection by the Owner's Representative. Container grown or balled and burlapped shrubs shall be pulled from holding blocks by the nurseryman for scrutiny by the Owner's Representative at no additional cost to the Owner. Trees held in storage shall not have branches tied up. Trees shall not have trunks obscured by burlap, cardboard trunk protection, or other devices that would otherwise obscure inspection. In the event that branches are tied up, trunks are obscured by burlap or cardboard trunk protection, or the Owner's Representative cannot inspect root flares, trunks or branching habit, the Contractor shall bear all responsibility and costs associated with tree rejection at a later date during the course of the Contract.
 - 6. Inspection and approval of plants at the source shall not impair the right of subsequent inspection and rejection upon delivery to the site, or during the progress of the Work, if the Owner's Representative finds that plants do not meet the requirements of the PLANT LIST or this Contract, have declined noticeably due to handling abuse, lack of maintenance, or other causes. Cost of replacements, as required, shall be borne by the Contractor.

- G. Placement of Loam for planting soil shall be specified, performed, and paid for under the Work of Section, Planting Soils. Obtain Owner's Representatives written approval of Work of rough grading and finish grading prior to starting the Work of planting.
- H. Notify the Owner's Representative three Working days prior to the proposed arrival of plant material on the site. If not planted within 24 hours of delivery to the site, all plants shall be maintained in an on-site nursery. Container grown shrubs stored on site shall be shaded from direct sunlight at all times and shall not be stored directly on paved surfaces. All plants delivered to the site and not planted within 24 hours of delivery shall have their root balls covered with mulch and shall be watered on a daily basis such that root balls are kept moist throughout.
1. Locations for all plants and outlines for planting areas shall be staked on the ground by the Contractor for approval by the Owner's Representative before any plant pits or plant beds are dug. Notify the Owner's Representative no less than 3 days prior to the desired date of inspection of staking to schedule site visit.
 2. All plant pits dug with a machine shall have the sides of the holes scraped with hand shovels to prevent glazing or compaction of the sides of the hole. Remove and stockpile excavated loam for reuse as backfill for plant pit. All subsoil excavated from the bottoms of planting pits shall be removed from the site.
 3. All plant pits shall be hand dug. All subsoil excavated from the bottoms of planting pits shall be removed from the site.
 4. Plant pits shall be dug to the dimensions shown on the Contract Documents.
 - a. Plant pits for trees shall be a minimum three times greater in diameter than the diameter of the root ball. Place root ball directly on subgrade. Slope sides of tree pits at a 45-degree angle.
 - b. Plant beds for shrub massing shall be one large and continuous excavated bed. Extend bed no less than 3 feet beyond limits of shrub root balls on perimeter of bed.
 - c. Plant pits for trees and shrubs shall be dug to the depth of the rootball to be planted.
 - d. Remove all soil from around the root flare of the stem of the plant and from the top of the rootball to determine the true depth of the rootball. All plants that have been planted and have root flares that are buried will be rejected.
 5. Groundcover, Bulb, and Perennial Beds:
 - a. Groundcover, bulb and perennial beds shall be dug to a continuous depth of 1 foot below final grade, or as shown on the Contract Documents and replace with sufficient planting soil mix. Remove groundcover and perennials from their pots immediately before planting. Handle plants carefully to prevent damaging roots. Place each plant in individual hole and firm the planting mix around the roots. Water thoroughly and mulch. Groundcover plants may be planted after the planting mulch is placed.
 - b. Bulbs shall be planted at depths as recommended by bulb supplier, as shown on the Contract Documents, or both. Bone meal shall be applied at the rate of 1/2 pound to every 25 square feet of area of bulbs. Bulbs shall have bone meal added as they are planted.
 6. All plant roots and earth balls must be damp and thoroughly protected from sun and wind from the beginning of the digging operation, during transportation, and at the site until the final planting.
 7. Remove container plants from containers prior to planting.

8. Trees and shrubs shall be placed in the center of plant pits, plumb, with the crown of their roots exposed and located above the surrounding finish grade.
 9. Prior to completion of planting installations, remove rope and cut wire baskets from the top 1/3 of the root balls. Pull burlap away from the trunk or stem of the plant and cut burlap from the top 1/3 of the root balls.
 10. Contractor shall 'butterfly' the root system for all container grown perennials immediately prior to planting them. Butterflying shall consist of vertically cutting the containerized root ball with a spade through the bottom half of the rootball followed by gently pulling the rootball open at the cut while placing it into the planting hole. The butterflied root system shall be placed over a small ridge of soil in the planting pit in order to assure as much soil to root ball contact as possible and to keep the halves apart.
 11. Planting soil shall be backfilled with approved planting soil to the full depth of the planting pit or bed. Eliminate air pockets and compact the soil by flooding the tree pit or plant bed within 2 hours of planting installation. After water has drained from the planting pit or bed and planting backfill has dried enough additional planting soil shall be spread in pit or bed to bring the finished surface of the planting pit or bed to grades shown on the Contract Documents. A saucer shall be formed around each plant at a depth of 3 inches for trees and for shrubs.
 12. Fertilizer shall be spread over the plant saucer or plant bed between the saucer and the edge of the rootball and till the fertilizer into the soil to a depth of four inches prior to the placement of the planting mulch. Fertilizer shall be provided, spread and paid for under Section, Planting Soils. Do not mulch until placement of the fertilizer has been verified by the Owner's Representative. Fertilizer application rates shall be as determined by soil testing, analysis, and testing laboratory recommendations specified, performed and paid for under Section: Planting Soils.
 13. All plants shall be inoculated with mycorrhizal fungi. Inoculant shall be added after the plants have been placed in their holes. Open the required number of packets for each plant and thoroughly mix the inoculant powder into the upper 10 inches of backfill soil.
 - a. Mycorrhizal fungal inoculant shall be added to the plant pits according to plant size.
 - b. The application rates for mycorrhizal fungal packets shall be in accordance with the manufacturer's recommendations.
 - c. Submit the purchasing receipt showing the total quantity purchased for the Project prior to installation. Submit empty packets of fungal spore inoculant to the Owner's Representative for verification of use. Owner's Representative will excavate tree pits to determine presence of mycorrhizal fungal inoculant.
 14. Tree staking shall be provided as shown on the contract documents.
- I. All plants shall be watered immediately following planting as necessary to thoroughly moisten rootball and plant pit loam and thereafter shall be inspected frequently for watering needs and watered, as required, to provide adequate moisture in the planting pit. The Contractor shall inspect tree pits 24 hours after initial watering to confirm that they are draining properly. If surface water or excessively saturated plant pit soils exist, the Contractor shall immediately notify the Owner's Representative. The Owner's Representative will recommend remedial measures based upon site conditions.
- J. Keeping Trees Plumb:

1. Contractor shall keep trees plumb and upright at all times. To this end the Contractor shall monitor plants on a regular basis and, if a tree is moved out of plumb, then straighten the tree to a vertical, upright condition.
 2. Reset trees that have moved out of plumb by carefully excavating the soil from the base of the rootball facing away from the direction of tilt and easing the tree upright into a vertical, plump position. Upon righting the tree, firmly press the soil around the base of the rootball to reset the tree.
- K. Mulch material shall be placed over entire saucer areas of individual trees and shrubs and over the entire area of planting beds to a depth of 3 inches after settlement, not later than one week after planting. Do not apply mulch prior to the first watering of plant materials. Do not apply mulch prior to placement of surface applied fertilizer and verification of placement by the Owner's Representative.
- L. Pruning:
1. As directed by the Owner's Representative, each plant shall be pruned in accordance with the Workmanship requirements of "Pruning Standards" for Class I, fine pruning, to preserve the natural character of the plant.
 2. Tree pruning, as required, shall be undertaken to the full height of affected trees.
 3. All dead wood or suckers and all broken or badly bruised branches shall be removed. Never cut a leader.
- M. Antidesiccant shall be applied to all evergreen and broadleaf evergreen plants in that are planted during the fall season if planted after Nov. 1 according to manufacturer's application recommendations and as directed by the Owner's Representative.
- N. Spraying of insecticides or herbicides shall be done by State-licensed professionals. Spraying for insects, pests and diseases shall conform to the National Arborist Association Standards under the section entitled "Standards for Pesticide Application Operations", as currently adopted and as approved by the Owner's Representative. All insecticides, pesticides, and herbicides shall be EPA-approved.
- O. If planting is done after lawn preparation or installation, proper protection of lawn areas shall be provided. Any damage resulting from planting operations shall be repaired immediately at no cost to the Owner.
- P. In the event that rock or underground construction Work or obstructions are encountered in any plant pit or bed excavation Work, alternate locations will be selected by the Owner's Representative. Relocation of plant pits or beds shall be provided at no additional cost to the Owner. Provide the Owner's Representative with no less than 48 hours' notice of obstruction so that a site visit can be scheduled to establish new locations for plants.
- Q. Absolutely no debris may be left on the site. Repair any damage to site as directed by the Owner's Representative, at no additional cost.

3.2 MAINTENANCE

- A. Maintenance shall begin immediately after each plant is planted and shall continue for a minimum 30-day Monitoring Period and until Final Acceptance.

- B. Maintenance shall consist of keeping the plants in a healthy growing condition and shall include, but is not limited to watering, weeding, cultivating, pruning, re-mulching, straightening of trees to, a plumb position, removal of dead material, resetting plants to proper grades or upright position, and maintaining the planting saucer.
- C. Plants shall be inspected for watering needs at least twice each week and watered to promote plant growth and vitality. The following watering rates assume that the soil is free draining. If the on-site conditions do not ensure a free draining soil, then notify the Owner's Representative in writing of this condition. Watering rates for trees, shrubs, ground cover, vines and perennials in free draining soils are presented here as guidelines to ensure that the top six inches of plant bed soil remains moist at all times. Actual watering rates may vary depending upon soil conditions.
 - 1. For trees in lawn or mulched beds, apply water to the ground surface directly under the canopy. Water shall be applied at a sufficiently slow rate to prevent run off from the soil surface, but great enough to equal 0.2 inches of water per square foot of canopy area per hour for 5 hours per week.
 - 2. Planting beds and individual plant pits shall be kept free of weeds, and mulch shall be replaced as required to maintain the specified layer of mulch. Beds and individual pits shall be neat in appearance and maintained to the designed layout.
 - 3. Plants that die during the maintenance period shall be removed and replaced by the Contractor within one week of notification and replaced during that growing season, unless directed otherwise by the Owner's Representative.
 - 4. Work of pruning, fertilizing, spraying, and similar activities shall be undertaken only by Certified Arborists and licensed chemical applicators, as pertinent to the Work being performed.
- D. During the maintenance period, any decline in the condition of plantings shall require the Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, the Contractor shall engage professional arborists and/or horticulturalists to inspect plant materials and to identify problems and recommend corrective procedures. The Owner's Representative shall be immediately advised of such actions. Inspection and recommendation reports shall be submitted to the Owner's Representative.

3.3 ACCEPTANCE

- A. Upon completion of all planting Work, the Contractor shall request in writing that the Owner's Representative formally inspect the planting Work.
- B. If plant materials and Workmanship are acceptable, the Owner's Representative will issue a written Certificate of Conditional Acceptance to the Contractor.
- C. Following the issuance of the Certificate of Conditional Acceptance to the Contractor, the Contractor shall maintain the plants for a minimum 30-day Monitoring Period. At the end of the Monitoring Period, the plant material will be inspected by the Owner's Representative to determine whether or not all planting Work has been performed to the requirements of this Section.
- D. Acceptance Standards at end of the Monitoring Period: If plant material is reviewed when it is in full leaf, leaves shall be plump with water with a shape indicative of the species and shall be free of insect, pest and disease damage. Twigs shall have living cambium

for their full length. Twigs and branches shall have a full bud set for their full length, including terminal buds. Trunks and branches shall be free of frost cracks; sun scald; damage due to insects, pests, and disease; structural defects; and damage resulting from machinery or tools. Plant material inspected and reviewed when the plants are not in full leaf shall have twigs, branches and trunks meeting the above requirements. All plants regardless of the season of review shall have a minimum of 75 percent healthy, balanced branching structure with a healthy terminal leader(s) with viable terminal bud(s).

- E. If any number of plants do not meet these Acceptance Standards at the time of inspection, or if in the Owner's Representative's opinion Workmanship is unacceptable, written notice will be given by the Owner's Representative to the Contractor in the form of a punch list, which itemizes necessary planting replacements and/or other deficiencies to be remedied. The Contractor's responsibility for maintenance of all plants shall be extended until replacements are made or other deficiencies are corrected. All plants that do not meet these Acceptance Standards shall be removed from the Project within seven days of receipt of the punch list. Replacements shall conform in all respects to the Specifications for new plants and shall be planted in the same manner.
- F. Following the correction of all Punch List deficiencies, the Contractor shall request in writing that the Owner's Representative formally inspect the planting Work. If plant materials and Workmanship are acceptable, the Owner's Representative will issue a written Certificate of Final Acceptance to the Contractor.

3.4 GUARANTEE

- A. The date of the Certificate of Final Acceptance shall establish the beginning of the maintenance period and the commencement of the required one-year guarantee and establishment period for planting Work.
- B. At the end of the guarantee and establishment period, a final inspection will be held to determine whether any plant material replacements are required. Each plant shall be plumb, shall have a character that is natural for its species as determined by the Owner's Representative, and shall conform to the Acceptance Standards described in this Section. Plants found to be unacceptable shall be removed promptly from the site and replaced according to this Section. A final inspection will be made after the replacement plants have lived through one year.
- C. All replacements shall be plants of the same kind and size specified in the PLANT LIST. The cost shall be borne by the Contractor, except for possible replacements due to vandalism or neglect on the part of others.

END OF SECTION

Item 100

Preparing Right of Way



1. DESCRIPTION

Prepare the right of way and designated easements for construction operations by removing and disposing of all obstructions when removal of such obstructions is not specifically shown on the plans to be paid by other Items.

2. CONSTRUCTION

Protect designated features on the right of way and prune trees and shrubs as directed. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation. Treat cuts on trees with an approved tree wound dressing within 20 min. of making a pruning cut or otherwise causing damage to the tree when shown on the plans. Follow all local and state regulations when burning. Pile and burn brush at approved locations as directed. Coordinate work with state and federal authorities when working in state or national forests or parks. Test, remove, and dispose of hazardous materials in accordance with Article 6.10., "Hazardous Materials."

Clear areas shown on the plans of all obstructions, except those landscape features that are to be preserved. Such obstructions include remains of houses and other structures, foundations, floor slabs, concrete, brick, lumber, plaster, septic tank drain fields, basements, abandoned utility pipes or conduits, equipment, fences, retaining walls, and other items as specified on the plans. Remove vegetation and other landscape features not designated for preservation, curb and gutter, driveways, paved parking areas, miscellaneous stone, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, and debris, whether above or below ground. Removal of live utility facilities is not included in this Item. Remove culverts, storm sewers, manholes, and inlets in proper sequence to maintain traffic and drainage.

Notify the Engineer in writing when items not shown on the plans and not reasonably detectable (buried with no obvious indication of presence) are encountered and required to be removed. These items will be handled in accordance with Article 4.5., "Differing Site Conditions."

Remove obstructions not designated for preservation to 2 ft. below natural ground in areas receiving embankment. Remove obstructions to 2 ft. below the excavation level in areas to be excavated. Remove obstructions to 1 ft. below natural ground in all other areas. Cut trees and stumps off to ground level when allowed by the plans or directed. Plug the remaining ends of abandoned underground structures over 3 in. in diameter with concrete to form a tight closure. Backfill, compact, and restore areas where obstructions have been removed unless otherwise directed. Use approved material for backfilling. Dispose of wells in accordance with Item 103, "Disposal of Wells."

Accept ownership, unless otherwise directed, and dispose of removed materials and debris at locations off the right of way in accordance with local, state, and federal requirements.

3. MEASUREMENT

This Item will be measured by the acre; by the 100-ft. station, regardless of the width of the right of way; or by each tree removed.

4. PAYMENT

For "acre" and "station" measurement, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Preparing Right of Way." For "each"

measurement, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Preparing Right of Way (Tree)" of the diameter specified. This price is full compensation for pruning of designated trees and shrubs; removal and disposal of structures and obstructions; backfilling of holes; furnishing and placing concrete for plugs; and equipment, labor, tools, and incidentals.

Total payment of this Item will not exceed 10% of the original contract amount until final acceptance. The remainder will be paid on the estimate after the final acceptance under Article 5.12., "Final Acceptance."

Item 104

Removing Concrete



1. DESCRIPTION

Break, remove, and salvage or dispose of existing hydraulic cement concrete.

2. CONSTRUCTION

Remove existing hydraulic cement concrete from locations shown on the plans. Avoid damaging concrete that will remain in place. Saw-cut and remove the existing concrete to neat lines. Replace any concrete damaged by the Contractor at no expense to the Department. Accept ownership and properly dispose of broken concrete in accordance with federal, state, and local regulations unless otherwise shown on the plans.

3. MEASUREMENT

Removing concrete pavement, floors, porches, patios, riprap, medians, foundations, sidewalks, driveways, and other appurtenances will be measured by the square yard (regardless of thickness) or by the cubic yard of calculated volume, in its original position.

Removing curb, curb and gutter, and concrete traffic barrier will be measured by the foot in its original position. The removal of monolithic concrete curb or dowelled concrete curb will be included in the concrete pavement measurement.

Removing retaining walls will be measured by the square yard along the front face from the top of the wall to the top of the footing.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

4. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Concrete" of the type specified. This price is full compensation for breaking the concrete; loading, hauling, and salvaging or disposing of the material; and equipment, labor, tools, and incidentals.

Removing retaining wall footings will not be paid for directly but will be considered subsidiary to this Item.

Item 105

Removing Treated and Untreated Base and Asphalt Pavement



1. DESCRIPTION

Break, remove, and store or dispose of existing asphalt pavement, including surface treatments, and treated or untreated base materials.

2. CONSTRUCTION

Break material retained by the Department into pieces not larger than 24 in. unless otherwise shown on the plans. Remove existing asphalt pavement before disturbing stabilized base. Avoid contamination of the asphalt materials and damage to adjacent areas. Repair material damaged by operations outside the designated locations.

Stockpile materials designated salvageable at designated sites when shown on the plans or as directed. Prepare stockpile site by removing vegetation and trash and by providing for proper drainage. Material not designated to be salvaged will become the property of the Contractor. When this material is disposed of, do so in accordance with federal, state, and local regulations.

3. MEASUREMENT

This Item will be measured by the 100-ft. station along the baseline of each roadbed, by the square yard of existing treated or untreated base and asphalt pavement in its original position, or by the cubic yard of existing treated or untreated base and asphalt pavement in its original position, as calculated by the average end area method. Square yard and cubic yard measurement will be established by the widths and depths shown on the plans and the lengths measured in the field.

4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Treated and Untreated Base and Asphalt Pavement" of the depth specified. This price is full compensation for breaking the material, loading, hauling, unloading, stockpiling or disposing; repair to areas outside designated locations for removal; and equipment, labor, tools, and incidentals.

Item 110

Excavation



1. DESCRIPTION

Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.

2. CONSTRUCTION

Accept ownership of unsuitable or excess material and dispose of material in accordance with local, state, and federal regulations at locations outside the right of way.

Maintain drainage in the excavated area to avoid damage to the roadway section. Correct any damage to the subgrade caused by weather at no additional cost to the Department.

Shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides as directed.

2.1. Rock Cuts. Excavate to finish subgrade. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods," unless excavation is to clean homogenous rock at finish subgrade elevation. Use approved embankment material compacted in accordance with Section 132.3.4., "Compaction Methods," to replace undercut material at no additional cost if excavation extends below finish subgrade.

2.2. Earth Cuts. Excavate to finish subgrade. Scarify subgrade to a uniform depth at least 6 in. below finish subgrade elevation in areas where base or pavement structure will be placed on subgrade. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods."

Take corrective measures as directed if unsuitable material is encountered below subgrade elevations.

2.3. Subgrade Tolerances. Excavate to within 1/2 in. in cross-section and 1/2 in. in 16 ft. measured longitudinally for turnkey construction. Excavate to within 0.1 ft. in cross-section and 0.1 ft. in 16 ft. measured longitudinally for staged construction.

3. MEASUREMENT

This Item will be measured by the cubic yard in its original position as computed by the method of average end areas.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Limits of measurement for excavation in retaining wall areas will be as shown on the plans.

Shrinkage or swelling factors will not be considered in determining the calculated quantities.

4. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Roadway)," "Excavation (Channel),"

"Excavation (Special)," or "Excavation (Roadway and Channel)." This price is full compensation for authorized excavation; drying; undercutting subgrade and reworking or replacing the undercut material in rock cuts; hauling; disposal of material not used elsewhere on the project; scarification and compaction; and equipment, labor, materials, tools, and incidentals.

Drying required deeper than 6 in. below subgrade elevation will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation and replacement of unsuitable material below subgrade elevations will be performed and paid for in accordance with the applicable bid items. However, if Item 132, "Embankment," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When a slide not due to the Contractor's negligence or operation occurs, payments for removal and disposal of the slide material will be in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation in backfill areas of retaining walls will not be measured or paid for directly but will be subsidiary to pertinent Items.

Item 216

Proof Rolling



1.	DESCRIPTION Proof-roll earthwork, base, or both to locate unstable areas.
2.	EQUIPMENT 2.1. Specified Equipment. Furnish rollers that weigh at least 25 tons when loaded. The maximum acceptable load is 50 tons. Provide rollers that meet the requirements of Section 210.2.4., "Pneumatic Tire Rollers." 2.2. Alternative Equipment. The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment in the same period of time as approved. Discontinue the use of the alternative equipment and furnish the specified equipment if the desired results are not achieved.
3.	CONSTRUCTION Perform proof rolling as directed. Adjust the load and tire inflation pressures within the range of the manufacturer's charts or tabulations, as directed. Make at least 2 coverages with the proof roller. Offset each trip of the roller by at most one tire width. Operate rollers at a speed between 2 and 6 mph, as directed. Correct unstable or nonuniform areas, if found, in accordance with the applicable Item.
4.	MEASUREMENT Rolling will be measured by the hour operated on surfaces being tested.
5.	PAYMENT The work performed and equipment furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Proof Rolling." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

Item 260

Lime Treatment (Road-Mixed)



1. DESCRIPTION

Mix and compact lime, water, and subgrade or base (with or without asphaltic concrete pavement) in the roadway.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. Obtain verification from the Engineer that the specification requirements are met before using the sources. The Engineer may sample and test project materials at any time before compaction. Use [Tex-100-E](#) for material definitions.

- 2.1. Lime. Furnish lime that meets the requirements of [DMS-6350](#), "Lime and Lime Slurry," and [DMS-6330](#), "Pre-Qualification of Lime Sources." Use hydrated lime, commercial lime slurry, quicklime, or carbide lime slurry as shown on the plans. Do not use quicklime when sulfates are present in quantities greater than 3,000 ppm. When furnishing quicklime, provide it in bulk.
- 2.2. Subgrade. The Engineer will determine the sulfate content of the existing subgrade in accordance with [Tex-145-E](#) and organic content in accordance with [Tex-148-E](#) before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 1.0% and proceed as directed.
- 2.3. Flexible Base. Unless otherwise shown on the plans, furnish base material that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans, before the addition of lime.
- 2.4. Water. Furnish water free of industrial wastes and other objectionable material.
- 2.5. Asphalt. When asphalt or emulsion is permitted for curing purposes, furnish materials that meet the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or as directed.
- 2.6. Mix Design. The Engineer will determine the target lime content and optimum moisture content in accordance with [Tex-121-E](#) or prior experience with the project materials. The Contractor may propose a mix design developed in accordance with [Tex-121-E](#). The Engineer will use [Tex-121-E](#) to verify the Contractor's proposed mix design before acceptance. Reimburse the Department for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor. Limit the amount of recycled asphalt pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.

- 3.1. Storage Facility. Store quicklime and dry hydrated lime in closed, weatherproof containers.
- 3.2. Slurry Equipment. Use slurry tanks equipped with agitation devices to slurry hydrated lime or quicklime on the project or other approved location. The Engineer may approve other slurring methods.

- 3.3. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with [Tex-600-J](#), Part I, when using commercial lime slurry or carbide lime slurry.
- 3.4. Hydrated Lime Distribution Equipment. Provide equipment to spread lime evenly across the area to be treated. Provide equipment with a rotary vane feeder to spread lime, when shown on the plans.
- 3.5. Pulverization Equipment. Provide pulverization equipment that:
- cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut,
 - provides a visible indication of the depth of cut at all times, and
 - uniformly mixes the materials.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

- 4.1. Preparation of Subgrade or Existing Base for Treatment. Before treating, remove existing asphalt pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape existing material in accordance with applicable bid items to conform to typical sections shown on the plans and as directed.

Unless otherwise approved, proof roll the roadbed in accordance with Item 216, "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

When material is imported from a borrow source, notify the Engineer of the location of the borrow source well in advance to allow time for testing and approval to avoid delay to the project. Stockpile as directed. The Engineer will test the borrow source and determine the sulfate and organic contents. When the borrow source has a sulfate content greater than 3,000 ppm or an organic content greater than 1.0%, proceed as directed.

When new base material is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix new base with existing material to provide a uniform mixture to the specified depth before shaping.

- 4.2. Pulverization. Pulverize or scarify existing material after shaping so that 100% passes a 2-1/2 in. sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

- 4.3. Application of Lime. Uniformly apply lime using dry or slurry placement as shown on the plans or as directed. Add lime at the percentage determined in Section 260.2.6., "Mix Design." Apply lime only on an area where mixing can be completed during the same working day.

Start lime application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of lime by wind. Do not apply lime when wind conditions, in the opinion of the Engineer, cause blowing lime to become dangerous to traffic or objectionable to adjacent property owners. When pebble grade quicklime is placed dry, mix the material and lime thoroughly at the time of lime application. Use of quicklime can be dangerous. Inform users of the recommended precautions for handling and storage.

- 4.3.1. Dry Placement. Before applying lime, bring the prepared roadway to approximately 2 percentage points above optimum moisture content. When necessary, sprinkle in accordance with Item 204, "Sprinkling." Distribute the required quantity of hydrated lime or pebble grade quicklime with approved equipment. Only hydrated lime may be distributed by bag. Do not use a motor grader to spread hydrated lime.
- 4.3.2. Slurry Placement. Provide slurry free of objectionable materials, at or above the minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry or carbide lime slurry to the jobsite, or use hydrated lime or quicklime to prepare lime slurry at the jobsite or other approved location, as specified. When dry quicklime is applied as slurry, use 80% of the amount shown on the plans.
- Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached. Uniformly spread the residue from quicklime slurry over the length of the roadway being processed, unless otherwise directed.
- 4.4. Mixing. Begin mixing within 6 hr. of application of lime. Hydrated lime exposed to the open air for 6 hr. or more between application and mixing, or that experiences excessive loss due to washing or blowing, will not be accepted for payment.

Thoroughly mix the material and lime using approved equipment. When treating subgrade, bring the moisture content above the optimum moisture content to insure adequate chemical reaction of the lime and subgrade materials. Allow the mixture to mellow for 1 to 4 days, as directed. When pebble grade quicklime is used, allow the mixture to mellow for 2 to 4 days, as directed. Sprinkle the treated materials during the mixing and mellowing operation, as directed, to achieve adequate hydration and proper moisture content. When the material to be treated has a sulfate content greater than 3,000 ppm but less than or equal to 7,000 ppm, mellow for a minimum of 7 days. Maintain in a continuously moist condition by sprinkling in accordance with Item 204, "Sprinkling." After mellowing, resume mixing until a homogeneous, friable mixture is obtained. After mixing, the Engineer may sample the mixture at roadway moisture and test in accordance with [Tex-101-E](#), Part III, to determine compliance with the gradation requirements in Table 1.

Table 1
Gradation Requirements (Minimum % Passing)

Sieve Size	Base	Subgrade
1-3/4"	100	100
3/4"	85	85
#4	—	60

- 4.5. Compaction. Compact the mixture using density control, unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. Sprinkle the treated material in accordance with Item 204, "Sprinkling" or aerate the treated material to adjust the moisture content during compaction so that it is no more than 1.0 percentage points below optimum and 2.0 percentage points above optimum as determined by [Tex-121-E](#). Measure the moisture content of the material in accordance with [Tex-115-E](#) or [Tex-103-E](#) during compaction daily and report the results the same day, unless otherwise shown on the plans or directed.

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Before final acceptance, the Engineer will select the locations of tests in each unit and measure the treated depth in accordance with [Tex-140-E](#). Correct areas deficient by more than 1/2 in. in thickness or more than 1/2% in target lime content by adding lime as required, reshaping, recompacting, and refinishing at the Contractor's expense.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification

requirements are met. Rework in accordance with Section 260.4.6., "Reworking a Section." Perform the work at no additional expense to the Department.

- 4.5.1. Ordinary Compaction. Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.
- 4.5.2. Density Control. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#). The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.
 - 4.5.2.1. Subgrade. Compact to at least 95% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans.
 - 4.5.2.2. Base. Compact the bottom course to at least 95% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans. Compact subsequent courses treated under this Item to at least 98% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans.
- 4.6. Reworking a Section. When a section is reworked within 72 hr. after completion of compaction, rework the section to provide the required density. When a section is reworked more than 72 hr. after completion of compaction, add additional lime at 25% of the percentage determined in Section 260.2.6., "Mix Design." Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing as directed, compacting, and finishing. When density control is specified, determine a new maximum density of the reworked material in accordance with [Tex-121-E](#), and compact to at least 95% of this density.
- 4.7. Finishing. Immediately after completing compaction of the final course, clip, skin, or tight-blade the surface of the lime-treated material with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of at an approved location. Roll the clipped surface immediately with a pneumatic tire roller until a smooth surface is attained. Add small amounts of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades shown on the plans or as directed.

Finish grade of constructed subgrade to within 0.1 ft. in the cross-section and 0.1 ft. in 16 ft. measured longitudinally.

Correct grade deviations of constructed base greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape, and roll with a pneumatic-tire roller. Correct as directed if material is more than 1/4 in. low. Do not surface patch. The 72-hr. time limit required for completion of placement, compaction, and finishing does not apply to finishing required just before applying the surface course.
- 4.8. Curing. Cure for the minimum number of days shown in Table 2 by sprinkling in accordance with Item 204, "Sprinkling," or by applying an asphalt material at a rate of 0.05 to 0.20 gal. per square yard as directed. Maintain moisture during curing. Upon completion of curing, maintain the moisture content in accordance with Section 132.3.5., "Maintenance of Moisture and Reworking," for subgrade and Section 247.4.5., "Curing" for bases before placing subsequent courses. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Apply seals or additional courses within 14 calendar days of final compaction.

Table 2
Minimum Curing Requirements before Placing Subsequent Courses¹

Untreated Material	Curing (Days)
PI ≤ 35	2
PI > 35	5

1. Subject to the approval of the Engineer. Proof rolling may be required as an indicator of adequate curing.

5. MEASUREMENT

5.1. Lime. When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."

When lime is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

5.1.1. Hydrated Lime.

5.1.1.1. Dry. Lime will be measured by the ton (dry weight).

5.1.1.2. Slurry. Lime slurry will be measured by the ton (dry weight) of the hydrated lime used to prepare the slurry at the jobsite.

5.1.2. Commercial Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

5.1.3. Quicklime.

5.1.3.1. Dry. Lime will be measured by the ton (dry weight) of the quicklime.

5.1.3.2. Slurry. Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

5.1.4. Carbide Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

5.2. Lime Treatment. Lime treatment will be measured by the square yard of surface area. The dimensions for determining the surface area are established by the widths shown on the plans and the lengths measured at placement.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 260.6.1., "Lime," and Section 260.6.2., "Lime Treatment."

Furnishing and delivering new base will be paid for in accordance with Section 247.6.2., "Flexible Base (Roadway Delivery)." Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for in accordance with Section 260.6.2., "Lime Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with Item 216, "Proof Rolling."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Where subgrade to be treated under this Contract has sulfates greater than 7,000 ppm, work will be paid for in accordance with Article 4.4., "Changes in the Work."

Asphalt used solely for curing will not be paid for directly but will be subsidiary to this Item. Asphalt placed for curing and priming will be paid for under Item 310, "Prime Coat."

6.1. Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following types:

- Hydrated Lime (Dry),
- Hydrated Lime (Slurry),
- Commercial Lime Slurry,
- Quicklime (Dry),
- Quicklime (Slurry), or
- Carbide Lime Slurry.

This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

Lime used for reworking a section in accordance with Section 260.4.6., "Reworking a Section," will not be paid for directly but will be subsidiary to this Item.

6.2. Lime Treatment. Lime treatment will be paid for at the unit price bid for "Lime Treatment (Existing Material)," "Lime Treatment (New Base)," or "Lime Treatment (Mixing Existing Material and New Base)," for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying lime, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

Item 263

Lime Treatment (Plant-Mixed)



1. DESCRIPTION

Construct a base course composed of a mixture of flexible base, hydrated lime, and water, mixed in an approved plant.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of proposed sources of materials and of changes to material sources. The Engineer will verify that the requirements of this Item are met before the sources can be used. The Engineer may sample and test project materials at any time before compaction. Use [Tex-100-E](#) for material definitions.

- 2.1. Lime. Furnish hydrated lime that meets the requirements of [DMS-6350](#), "Lime and Lime Slurry," and [DMS-6330](#), "Pre-Qualification of Lime Sources."
- 2.2. Flexible Base. Furnish base material that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans, before the addition of lime.
- 2.3. Water. Furnish water free of industrial wastes and other objectionable material.
- 2.4. Asphalt. Furnish asphalt or emulsion when permitted for curing purposes that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or as directed.
- 2.5. Mix Design. Using the materials proposed for the project, the Engineer will determine the target lime content and optimum moisture content necessary to produce the required stabilized mixture. The mix will be designed in accordance with [Tex-121-E](#). The Contractor may propose a mix design developed in accordance with [Tex-121-E](#). The Engineer will use [Tex-121-E](#) to verify the Contractor's proposed mix design before acceptance. Reimburse the Department for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor. Limit the amount of asphalt concrete pavement to no more than 50% of the mix when treating existing materials unless otherwise shown on the plans or directed.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.

- 3.1. Storage Facility. Store hydrated lime in closed weatherproof containers.
- 3.2. Mixing Plant. Provide a stationary pugmill that uniformly mixes lime, water, and base material in the specified proportions. Obtain approval before providing weigh-batch or continuous mixers. Equip plants with automatic proportioning and metering devices. Ensure weighing and measuring equipment complies with Item 520, "Weighing and Measuring Equipment." Provide calibration documentation.
- 3.3. Spreader Equipment. Provide equipment that will spread the lime-treated mixture in a uniform layer in one pass when shown on the plans. Equip spreaders with electronic grade controls when shown on the plans.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed. Complete placing, compacting, and finishing within 72 hr. after the lime is added to the base material.

Start lime operations only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend operations when the Engineer determines that weather conditions are unsuitable.

- 4.1. Mixing. Thoroughly mix materials in the proportions designated on the mix design, in a plant that meets the requirements of Section 263.3.2., "Mixing Plant." Mix at optimum moisture content, unless otherwise directed, until a homogeneous mixture is obtained.

- 4.2. Placing. Place lime-treated base on a subgrade or base prepared in accordance with details shown on the plans. Bring the prepared roadway to the moisture content directed. Haul lime-treated base to the roadway in clean trucks and begin placement immediately. Spread and shape in a uniform layer with an approved spreader. Construct individual layers to the thickness shown on the plans, the same day as delivered, unless otherwise approved. Do not place lifts exceeding a compacted depth of 8 in. unless otherwise shown on the plans. Maintain the shape of the course by blading. Correct or replace segregated areas as directed, at no additional expense to the Department.

Construct vertical joints between segmented areas of lime-treated base. The vertical face may be created by using a header or by cutting back the face to approximately vertical. Place successive base courses using the same methods as the first course. Offset construction joints by at least 6 in.

- 4.3. Compaction. Compact the mixture using density control immediately after placing unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. Sprinkle the treated material when necessary in accordance with Item 204, "Sprinkling." Determine the moisture content of the mixture at the beginning and during compaction in accordance with [Tex-103-E](#).

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least 1/2 the width of the roller unit. Begin rolling at the low side and progress toward the high side on superelevated curves. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Rework in accordance with Section 263.4.4., "Reworking a Section." Perform the work at no additional expense to the Department.

- 4.3.1. Ordinary Compaction. Roll with approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompact.

- 4.3.2. Density Control. Compact the bottom course to at least 95% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans. Compact subsequent courses treated under this Item to at least 98% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans.

The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#). The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

Item 360

Concrete Pavement



1. DESCRIPTION

Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.

2. MATERIALS

- 2.1. Hydraulic Cement Concrete. Provide hydraulic cement concrete in accordance with Item 421, "Hydraulic Cement Concrete." Use compressive strength testing unless otherwise shown on the plans. Provide Class P concrete designed to meet a minimum average compressive strength of 3,200 psi or a minimum average flexural strength of 450 psi at 7 days or a minimum average compressive strength of 4,000 psi or a minimum average flexural strength of 570 psi at 28 days. Test in accordance with [Tex-448-A](#) or [Tex-418-A](#).
- Obtain written approval if the concrete mix design exceeds 520 lb. per cubic yard of cementitious material.
- Use coarse aggregates for continuously reinforced concrete pavements to produce concrete with a coefficient of thermal expansion not more than 5.5×10^{-6} in./in./°F. Provide satisfactory [Tex-428-A](#) test data from an approved testing laboratory if the coarse aggregate coefficient of thermal expansion listed on the Department's *Concrete Rated Source Quality Catalog* is not equal to or less than 5.5×10^{-6} in./in./°F.
- Provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic when shown on the plans or allowed. Design Class HES to meet the requirements of Class P and a minimum average compressive strength of 3,200 psi or a minimum average flexural strength of 450 psi in 24 hr., unless other early strength and time requirements are shown on the plans or allowed.
- Use Class A or P concrete meeting the requirements of Item 421, "Hydraulic Cement Concrete," and this Item for curbs that are placed separately from the pavement.
- 2.2. Reinforcing Steel. Provide Grade 60 or above, deformed steel for bar reinforcement in accordance with Item 440, "Reinforcement for Concrete." Provide positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving. Provide corrosion protection when shown on the plans.
- 2.2.1. Dowels. Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 440, "Reinforcement for Concrete." Coat dowels with a thin film of grease, wax, silicone or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.
- 2.2.2. Tie Bars. Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Furnish multiple piece tie bar assemblies from the list of approved multiple-piece tie bars that have been prequalified in accordance with DMS-4515, "Multiple Piece Tie Bars for Concrete Pavements," when used. Multiple-piece tie bars used on individual projects must be sampled in accordance with [Tex-711-I](#), and tested in accordance with DMS-4515 "Multiple Piece Tie Bars for Concrete Pavements."
- 2.3. Alternative Reinforcing Materials. Provide reinforcement materials of the dimensions and with the physical properties specified when allowed or required by the plans. Provide manufacturer's certification of required material properties.

- 2.4. Curing Materials. Provide Type 2 membrane curing compound conforming to [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS-1 emulsified asphalt conforming to Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 422, "Concrete Superstructures." Provide insulating blankets for curing fast track concrete pavement with a minimum thermal resistance (R) rating of 0.5 hour-square foot F/BTU. Use insulating blankets that are free from tears and are in good condition.
- 2.5. Epoxy. Provide Type III, Class C epoxy in accordance with [DMS-6100](#), "Epoxies and Adhesives," for installing all drilled-in reinforcing steel. Submit a work plan and request approval for the use of epoxy types other than Type III, Class C.
- 2.6. Evaporation Retardant. Provide evaporation retardant conforming to [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."
- 2.7. Joint Sealants and Fillers. Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with [DMS-6310](#), "Joint Sealants and Fillers."

3. EQUIPMENT

Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 421, "Hydraulic Cement Concrete." Obtain approval for other equipment used.

- 3.1. Placing, Consolidating, and Finishing Equipment. Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically-operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist.

When string-less paving equipment is used, use Section 5.9.3, "Method C," and establish control points at maximum intervals of 500 ft. Use these control points as reference to perform the work.

Provide mechanically-operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations. Provide immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at all joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators.

For small or irregular areas or when approved, the paving equipment described in this Section is not required.

- 3.2. Forming Equipment.
- 3.2.1. Pavement Forms. Provide metal side forms of sufficient cross-section, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100-ft. radius or less.
- 3.2.2. Curb Forms. Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter."

- 3.3. Reinforcing Steel Inserting Equipment. Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details when approved.
- 3.4. Texturing Equipment.
 - 3.4.1. Carpet Drag. Provide a carpet drag mounted on a work bridge or a manual moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications.
 - 3.4.2. Tining Equipment. Provide a self-propelled metal tine device equipped with steel tines with cross-section approximately 1/32 in. thick × 1/12 in. wide. Provide tines for transverse tining equipment spaced at approximately 1 in., center-to-center, or provide tines for longitudinal tining equipment spaced at approximately 3/4 in., center-to-center. Manual methods that produce an equivalent texture may be used when it is impractical to use self-propelled equipment, such as for small areas, narrow width sections, and in emergencies due to equipment breakdown.
- 3.5. Curing Equipment. Provide a self-propelled machine for applying membrane curing compound using mechanically-pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when required to meet the requirements of Section 360.4.9., "Curing." Hand-operated pressurized spraying equipment with atomizing nozzles may only be used on small or irregular areas, narrow width sections, or in emergencies due to equipment breakdown.
- 3.6. Sawing Equipment. Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations.
- 3.7. Grinding Equipment. Provide self-propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades when required. Provide equipment with automatic grade control capable of grinding at least a 3-ft. width longitudinally in each pass without damaging the concrete.
- 3.8. Testing Equipment. Provide testing equipment regardless of job-control testing responsibilities in accordance with Item 421, "Hydraulic Cement Concrete," unless otherwise shown on the plans or specified.
- 3.9. Coring Equipment. Provide coring equipment capable of extracting cores in accordance with the requirements of [Tex-424-A](#) when required.
- 3.10. Miscellaneous Equipment. Furnish both 10-ft. and 15-ft. steel or magnesium long-handled, standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations.

4. CONSTRUCTION

- Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water before placing pavement concrete.
- Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.
- 4.1. Paving and Quality Control Plan. Submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including

methods to construct transverse joints, methods to consolidate concrete at joints, longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.

- 4.2. Job-Control Testing. Perform all fresh and hardened concrete job-control testing at the specified frequency unless otherwise shown on the plans. Provide job-control testing personnel meeting the requirements of Item 421, "Hydraulic Cement Concrete." Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump and temperature to verify concrete conformance and consistency on start-up production days. Sample and prepare strength-test specimens (2 specimens per test) on the first day of production and for each 3,000 sq. yd. or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump and temperature tests each time strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

The Engineer will perform job-control testing when the testing by the Contractor is waived by the plans; however, this does not waive the Contractor's responsibility for providing materials and work in accordance with this Item.

- 4.2.1. Job-Control Strength. Use 7-day job-control concrete strength testing in accordance with [Tex-448-A](#) or [Tex-418-A](#) unless otherwise shown on the plans or permitted.

Use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,000 psi as correlated in accordance with [Tex-427-A](#) for 7-day job-control by compressive strength. Use a flexural strength of 450 psi or a lower job-control strength value proven to meet a 28-day flexural strength of 570 psi as correlated in accordance with [Tex-427-A](#) for 7-day job-control by flexural strength.

Job control of concrete strength may be correlated to an age other than 7 days in accordance with [Tex-427-A](#) when approved. Job-control strength of Class HES concrete is based on the required strength and time.

Investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause when a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive job-control strength values fall below the required job-control strength. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low-strength test values in a timely manner. The Engineer will evaluate the structural adequacy of the pavements if any job-control strength is more than 15% below the required job-control strength. Remove and replace pavements found to be structurally inadequate at no additional cost when directed.

- 4.2.2. Split-Sample Verification Testing. Perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 job-control samples. The Engineer will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or the average of 10 job-control strength results and the Engineer's split-sample strength result differ by more than 10%.

Table 1
Verification Testing Limits

Test Method	Allowable Differences
Temperature, Tex-422-A	2°F
Flexural strength, Tex-448-A	19%
Compressive strength, Tex-418-A	10%

- 4.3. Reinforcing Steel and Joint Assemblies. Accurately place and secure in position all reinforcing steel as shown on the plans. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the lap locations so that no more than 1/3 of the longitudinal steel is spliced in any given 12-ft. width and 2-ft. length of the pavement. Use multiple-piece tie bars, drill and epoxy grout tie bars, or, if approved, mechanically-inserted single-piece tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied or mechanically inserted into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of 3/4 of the yield strength of the steel after 7 days. Test 15 bars using ASTM E488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. Perform corrective measures to provide equivalent pullout resistance if any of the test results do not meet the required minimum pullout strength. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.
- 4.3.1. Manual Placement. Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.
- 4.3.2. Mechanical Placement. Complete the work using manual placement methods described above if mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies.
- 4.4. Joints. Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with Item 438, "Cleaning and Sealing Joints." Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. Install a rigid transverse bulkhead, for the reinforcing steel, and shaped accurately to the cross-section of the pavement when placing of concrete is stopped.
- 4.4.1. Placing Reinforcement at Joints. Complete and place the assembly of parts at pavement joints at the required location and elevation, with all parts rigidly secured in the required position, when shown on the plans.
- 4.4.2. Transverse Construction Joints.
- 4.4.2.1. Continuously Reinforced Concrete Pavement (CRCP). Install additional longitudinal reinforcement through the bulkhead when shown on the plans. Protect the reinforcing steel immediately beyond the construction joint from damage, vibration, and impact.
- 4.4.2.2. Concrete Pavement Contraction Design (CPCD). Install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location when the placing of concrete is intentionally stopped. Install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints when the placing of concrete is unintentionally stopped. Install tie bars of the size and spacing used in the longitudinal joints for mid-slab construction joints.
- 4.4.2.3. Curb Joints. Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. Place reinforcing steel into the plastic concrete pavement for non-monolithic curbs as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width

of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter."

- 4.5. **Placing and Removing Forms.** Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement.

Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met. Stop paving operations if forms settle or deflect more than 1/8 in. under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade.

Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hr. after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hr. after a bulkhead for a transverse construction joint has been removed unless otherwise approved. Promptly apply membrane curing compound to the edge of the concrete pavement when forms are removed before 72 hr. after concrete placement.

Forms that are not the same depth as the pavement, but are within 2 in. of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100-ft. radius or less.

- 4.6. **Concrete Delivery.** Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 in. Segregated concrete is subject to rejection.

Begin the discharge of concrete delivered in agitated delivery equipment conforming to the requirements of Item 421, "Hydraulic Cement Concrete." Place non-agitated concrete within 45 min. after batching. Reduce times as directed when hot weather or other conditions cause quick setting of the concrete.

- 4.7. **Concrete Placement.** Do not allow the pavement edge to deviate from the established paving line by more than 1/2 in. at any point. Place the concrete as near as possible to its final location, and minimize segregation and rehandling. Distribute concrete using shovels where hand spreading is necessary. Do not use rakes or vibrators to distribute concrete.

- 4.7.1. **Consolidation.** Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete along forms, at all joints and in areas not accessible to the machine-mounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.

- 4.7.2. **Curbs.** Conform to the requirements of Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter" where curbs are placed separately.

- 4.7.3. **Temperature Restrictions.** Place concrete that is between 40°F and 95°F when measured in accordance with [Tex-422-A](#) at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.

Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or

above 40°F. Protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period when temperatures warrant protection against freezing. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72 hr. after placement. Repair or replace all concrete damaged by freezing.

- 4.8. Spreading and Finishing. Finish all concrete pavement with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike-off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.
- 4.8.1. Finished Surface. Perform sufficient checks with long-handled 10-ft. and 15-ft. straightedges on the plastic concrete to ensure the final surface is within the tolerances specified in Surface Test A in Item 585, "Ride Quality for Pavement Surfaces." Check with the straightedge parallel to the centerline.
- 4.8.2. Maintenance of Surface Moisture. Prevent surface drying of the pavement before application of the curing system by means that may include water fogging, the use of wind screens, and the use of evaporation retardants. Apply evaporation retardant at the manufacturer's recommended rate. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shutdown of pavement operations.
- 4.8.3. Surface Texturing. Complete final texturing before the concrete has attained its initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet dragging operations while there is excessive bleed water.

A metal-tine texture finish is required unless otherwise shown on the plans. Provide transverse tining unless otherwise shown on the plans. Immediately following the carpet drag, apply a single coat of evaporation retardant, if needed, at the rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves approximately 3/16 in. deep, with a minimum depth of 1/8 in., and approximately 1/12 in. wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps, small or irregular areas, and narrow width sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

Target a carpet drag texture of 0.04 in., as measured by [Tex-436-A](#), when carpet drag is the only surface texture required on the plans. Ensure adequate and consistent macro-texture is achieved by applying enough weight to the carpet and by keeping the carpet from getting plugged with grout. Correct any location with a texture less than 0.03 in. by diamond grinding or shot blasting. The Engineer will determine the test locations at points located transversely to the direction of traffic in the outside wheel path.

- 4.8.4. Small, Irregular Area, or Narrow Width Placements. Use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade where machine placements and finishing of concrete pavement are not practical.
- 4.8.5. Emergency Procedures. Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.
- 4.9. Curing. Keep the concrete pavement surface from drying as described in Section 360.4.8.2., "Maintenance of Surface Moisture," until the curing material has been applied. Maintain and promptly repair damage to curing materials on exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24-hr. period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hr. or the surface temperature of the concrete is maintained above 40°F for 24 hr.

Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 422, "Concrete Superstructures," may be used when specified or approved.

- 4.9.1. Membrane Curing. Spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of no more than 180 sq. ft. per gallon. Apply the curing compound before allowing the concrete surface to dry.

Manage finishing and texturing operations to ensure placement of curing compound on a moist concrete surface, relatively free of bleed water, to prevent any plastic shrinkage cracking. Time the application of curing compound to prevent plastic shrinkage cracking.

Maintain curing compounds in a uniformly agitated condition, free of settlement before and during application. Do not thin or dilute the curing compound.

Apply additional compound at the same rate of coverage to correct damage where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage. Ensure that the curing compound coats the sides of the tining grooves.

- 4.9.2. Asphalt Curing. Apply a uniform coating of asphalt curing at a rate of 90 to 180 sq. ft. per gallon when an asphaltic concrete overlay is required. Apply curing immediately after texturing and once the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.

- 4.9.3. Curing Class HES Concrete. Provide membrane curing in accordance with Section 360.4.9.1., "Membrane Curing," for all Class HES concrete pavement. Promptly follow by wet mat curing in accordance with Section 422.4.8., "Final Curing," until opening strength is achieved but not less than 24 hr.

- 4.9.4. Curing Fast-Track Concrete Pavement. Provide wet mat curing unless otherwise shown on the plans or as directed. Cure in accordance with Section 422.4.8., "Final Curing." Apply a Type 1-D or Type 2 membrane cure instead of wet mat curing if the air temperature is below 65°F and insulating blankets are used.

- 4.10. Sawing Joints. Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw-cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hr. of curing.

- 4.11. Protection of Pavement and Opening to Traffic. Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown on the plans or as directed. Testing result interpretation for opening to traffic is subject to approval.

- 4.11.1. Protection of Pavement. Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Protect the pavement from damage due to crossings using approved methods before opening to traffic. Where a detour is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required.

Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

- 4.11.2. Opening Pavement to All Traffic. Pavement that is 7 days old may be opened to all traffic. Clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work before opening to traffic.
- 4.11.3. Opening Pavement to Construction Equipment. Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hr. old and opening strength has been demonstrated in accordance with Section 360.4.11.4., "Early Opening to All Traffic," before curing is complete. Keep delivery equipment at least 2 ft. from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 ft. from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.
- 4.11.4. Early Opening to All Traffic. Concrete pavement may be opened after curing is complete and the concrete has attained a flexural strength of 450 psi or a compressive strength of 3,200 psi, except that pavement using Class HES concrete may be opened after 24 hr. if the specified strength is achieved.
- 4.11.4.1. Strength Testing. Test concrete specimens cured under the same conditions as the portion of the pavement involved.
- 4.11.4.2. Maturity Method. Use the maturity method, [Tex-426-A](#), to estimate concrete strength for early opening pavement to traffic unless otherwise shown on the plans. Install at least 2 maturity sensors for each day's placement in areas where the maturity method will be used for early opening. Maturity sensors, when used, will be installed near the day's final placement for areas being evaluated for early opening. Use test specimens to verify the strength-maturity relationship in accordance with [Tex-426-A](#), starting with the first day's placement corresponding to the early opening pavement section.
- Verify the strength-maturity relationship at least every 10 days of production after the first day. Establish a new strength-maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength-maturity relationship deviates by more than 10% until a new strength-maturity relationship is established.
- The Engineer will determine the frequency of verification when the maturity method is used intermittently or for only specific areas.
- 4.11.5. Fast Track Concrete Pavement. Open the pavement after the concrete has been cured for at least 8 hr. and attained a minimum compressive strength of 1,800 psi or a minimum flexural strength of 255 psi when tested in accordance with Section 360.4.11.4.1., "Strength Testing," or Section 360.4.11.4.2., "Maturity Method," unless otherwise directed. Cover the pavement with insulating blankets when the air temperature is below 65°F until the pavement is opened to traffic.
- 4.11.6. Emergency Opening to Traffic. Open the pavement to traffic under emergency conditions, when the pavement is at least 72 hr. old when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.
- 4.12. Pavement Thickness. The Engineer will check the thickness in accordance with [Tex-423-A](#) unless other methods are shown on the plans. The Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of the paving equipment every 500 ft. or fraction thereof. Core where directed, in accordance with [Tex-424-A](#), to verify deficiencies of more than 0.2 in. from plan thickness and to determine the limits of deficiencies of more than 0.75 in. from plan thickness. Fill core holes using an approved concrete mixture and method.
- 4.12.1. Thickness Deficiencies Greater than 0.2 in. Take one 4-in. diameter core at that location to verify the measurement when any depth test measured in accordance with [Tex-423-A](#) is deficient by more than 0.2 in. from the plan thickness.

Take 2 additional cores from the unit (as defined in Section 360.4.12.3., "Pavement Units for Payment Adjustment" at intervals of at least 150 ft. and at selected locations if the core is deficient by more than 0.2 in., but not by more than 0.75 in. from the plan thickness, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 in. will be considered as the specified thickness plus 0.2 in.

- 4.12.2. Thickness Deficiencies Greater than 0.75 in. Take additional cores at 10-ft. intervals in each direction parallel to the centerline to determine the boundary of the deficient area if a core is deficient by more than 0.75 in. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 in., but not more than 1 in. Remove and replace the deficient areas without additional compensation or retain deficient areas without compensation, as directed. Remove and replace any area of pavement found deficient in thickness by more than 1 in. without additional compensation.
- 4.12.3. Pavement Units for Payment Adjustment. Limits for applying a payment adjustment for deficient pavement thickness from 0.20 in. to not more than 0.75 in. are 500 ft. of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards.
- For greater than 0.75 in. deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 in. deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10-ft. interval investigation as determined by the Engineer.
- Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 ft. wide or wider will be considered as lanes. Shoulders less than 6 ft. wide will be considered part of the adjacent lane.
- Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 ft. in length. Areas less than 500 ft. in length will be individually evaluated for payment adjustment based on the plan area.
- 4.13. Ride Quality. Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

This Item will be measured as follows:

- 5.1. Concrete Pavement. Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.
- 5.2. Curb. Curb on concrete pavement will be measured by the foot in place.

6. PAYMENT

These prices are full compensation for materials, equipment, labor, tools, and incidentals.

- 6.1. Concrete Pavement. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the adjusted unit price bid for "Concrete Pavement" of the type and depth specified as adjusted in accordance with Section 360.6.2., "Deficient Thickness Adjustment."
- 6.2. Deficient Thickness Adjustment. Where the average thickness of pavement is deficient in thickness by more than 0.2 in. but not more than 0.75 in., payment will be made using the adjustment factor as specified in Table 2 applied to the bid price for the deficient area for each unit as defined under Section 360.4.12.3., "Pavement Units for Payment Adjustment."

Table 2
Deficient Thickness Price Adjustment Factor

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (Adjustment Factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

- 6.3. Curb. Work performed and furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Curb" of the type specified.

Item 402

Trench Excavation Protection



1. DESCRIPTION

Furnish and place excavation protection for trenches 5 ft. or greater in depth.

2. CONSTRUCTION

Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR Part 1926, Subpart P, "Excavations."

3. MEASUREMENT

This Item will be measured by the foot along the long axis of the trench where the depth of trench exceeds 5 ft. This measurement includes all required trench protection, including trench ends.

4. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Trench Excavation Protection." This price is full compensation for excavation and backfill required for excavation protection; furnishing, placing, and removing shoring, sheeting, or bracing; de-watering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

Item 423

Retaining Walls



1. DESCRIPTION

Furnish, construct, and install retaining walls.

2. MATERIALS

2.1. General. Furnish materials in accordance with the following:

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete,"
- Item 445, "Galvanizing,"
- Item 458, "Waterproofing Membranes for Structures," and
- Item 556, "Pipe Underdrains."

Use concrete for retaining walls that conforms to the requirements of Table 1 unless otherwise shown on the plans.

Table 1
Concrete for Retaining Walls

Application	Concrete
Cast-in-place, non-reinforced	Class A
Cast-in-place, reinforced	Class C
Precast	Class H, $f_c = 4,000$ psi

Furnish concrete for machine-made concrete block units in accordance with ASTM C90, Class 1, Type II, except the minimum 28-day compressive strength must be 4,000 psi with maximum moisture absorption of 7%.

Provide Type 1 filter fabric in accordance with [DMS-6200](#), "Filter Fabric." Provide filter fabric rated as UV-resistant when used as part of the exposed facing for a temporary wall.

Joint fillers, pads, waterstops, and other incidental materials must be as shown on the plans or approved by the Engineer.

Epoxy coat all steel used in concrete panels and coping including connectors, dowels, stirrups, and reinforcing steel when the plans call for epoxy coating of steel earth reinforcements.

2.2. Definitions. This Item uses the following terms:

- **Permanent Wall.** A retaining wall with a design service life of 75 years. All walls are presumed to be permanent walls unless otherwise specified on the plans.
- **Temporary Wall.** A retaining wall so designated by description, with a design service life of 3 years.
- **Mechanically Stabilized Earth (MSE) Wall.** A wall consisting of a volume of select backfill with tensile earth reinforcement elements distributed throughout. Permanent MSE walls use a precast concrete panel as a facing element. Temporary MSE walls use welded wire fabric with filter fabric backing as a facing element.
- **Concrete Block Wall.** A retaining wall that uses machine-made, precast concrete block units as facing elements. The walls may use a volume of select fill with tensile earth reinforcements distributed throughout, or may use only the facing unit and unit fill weight for support.

- 2.3. Fabrication.
- 2.3.1. Cast-in-Place. Meet Item 420, "Concrete Substructures."
- 2.3.2. Formed Precast. Meet Item 424, "Precast Concrete Structural Members (Fabrication)."
- 2.3.3. Machine-Made Precast. Furnish machine-made concrete block units in accordance with ASTM C90, sampled and tested in accordance with ASTM C140. Furnish units with molded dimensions within 1/8 in. of specified dimensions, except height must be within 1/16 in.
- 2.4. Backfill.
- 2.4.1. Non-Select. Furnish non-select backfill for walls other than temporary and permanent MSE and concrete block walls as indicated on the plans. Non-select fill will meet Item 132, "Embankment," of the type specified on the plans. Provide material with a maximum plasticity index of 30 if no type is specified as determined by [Tex-106-E](#).
- 2.4.2. Select. Select backfill is required in specific areas of permanent and temporary MSE and concrete block-type retaining walls. Provide select backfill that is free from organic or otherwise deleterious materials and that conforms to the gradation limits shown in Table 2 as determined by [Tex-401-A](#).

Provide backfill that does not contain shale, caliche, or other soft, poor-durability coarse aggregate particles. Reclaimed Asphalt Pavement (RAP) is not allowed. Crushed Concrete or manufactured sand is allowed for temporary walls with a service life of 3 years or less. Test each source of backfill for durability/soundness using [Tex-411-A](#), 5-cycle magnesium sulfate soundness. Backfill material with a maximum 5-cycle soundness loss exceeding 25% will be rejected. Alternately, [Tex-461-A](#), Micro-Deval abrasion may be used if the corresponding results show loss is not greater than 20%, otherwise [Tex-411-A](#) governs aggregate verification.

Type AS, BS, and DS particles larger than 1/4 in. must be angular or completely crushed. Provide mechanically crushed gravel or stone backfill. Gravel from each aggregate source will have a minimum of 95% two or more mechanically induced crushed faces, as [Tex-460-A](#), Part I determines. Rounded rock or rounded gravel is not allowed. Natural sand meeting the requirements of this Section is permitted for use.

Table 2
Select Backfill Gradation Limits

Type	Sieve Size	Percent Retained
AS	3"	0
	1/2"	50–100
	#4	See Note
	#40	85–100
	#200	95–100
BS	3"	0
	#4	See Note
	#40	40–100
	#200	85–100
CS	3"	0
	#4	See Note
	#200	75–100
DS	3"	0
	3/8"	85–100
	#200	95–100

Note—Use No. 4 sieve for determination of rock backfill as described in this main paragraph, "Backfill."

When the backfill gradation results in 85% or more material retained on the No. 4 sieve, the backfill will be considered rock backfill. All Type DS backfill is considered rock backfill.

In addition to the requirements for Type CS select fill, the fraction finer than the No. 200 sieve must have a Plasticity Index (PI) in accordance with [Tex-106-E](#) not greater than 6.

Furnish Type BS backfill for permanent walls; Type CS backfill for temporary walls; and Type DS backfill for areas of walls subject to inundation unless otherwise shown on the plans, or below the 100-year flood elevation as noted on the plans.

Furnish backfill meeting the requirements of this Section but with a maximum particle size of 3/4 in. when nonmetallic or epoxy coated earth reinforcements are used.

- 2.4.3. Drainage Aggregate. Use drainage aggregate to fill the void within concrete block units and in the zone 1 ft. behind the units. Provide drainage aggregate that is free from organic or otherwise deleterious materials and that conforms to the gradation limits in Table 3 as [Tex-110-E](#) determines.

Table 3
Drainage Aggregate Gradation Limits

Sieve Size	Percent Retained
1"	0
3/4"	25–50
1/2"	50–100
#4	75–100

- 2.4.4. Cement-Stabilized Backfill. Use cement-stabilized backfill when required or as approved. Stabilize Type CS backfill with 5% hydraulic cement by dry weight of the backfill material. Use a stationary plant to thoroughly mix the backfill material, cement, and water. Place and compact the backfill within 2 hours of mixing. Provide special drainage provisions when cement-stabilized backfill is used, as shown on the plans.

- 2.4.5. Electrochemical. Provide backfill meeting the following additional requirements for permanent retaining wall systems using galvanized metallic earth reinforcements:

- The pH is between 5.5 and 10.0 as [Tex-128-E](#) determines.
- Resistivity is more than 3,000 ohm-cm as [Tex-129-E](#) determines.
- Material with resistivity between 1,500 and 3,000 ohm-cm may be used if the chloride content is less than 100 ppm and the sulfate content is less than 200 ppm as [Tex-620-J](#) determines.

Perform electrochemical testing on the raw, unstabilized backfill material when cement-stabilized backfill is used.

- 2.5. Earth Reinforcements. Furnish earth reinforcements that meet the design requirements. Galvanize or epoxy coat all steel elements for permanent walls in contact with soil. Epoxy coat in accordance with Item 440, "Reinforcement for Concrete," except provide a minimum 18-mil coating thickness. Epoxy coat the reinforcing only when shown on the plans or as approved. Use connection hardware that is likewise nonmetallic or epoxy coated when using nonmetallic or epoxy coated earth reinforcements.

3. CONSTRUCTION

- 3.1. General. Construct retaining walls in accordance with details shown on the plans, on the approved working drawings, and to the pertinent requirements of the following Items:

- Item 110, "Excavation"
- Item 132, "Embankment"
- Item 400, "Excavation and Backfill for Structures"
- Item 420, "Concrete Substructures"
- Item 458, "Waterproofing Membranes for Structures"
- Item 556, "Pipe Underdrains"

Construct required piling or drilled shafts in accordance with the pertinent specification.

- 3.2. Options. When optional design details are shown on the plans, the Contractor is required to use the same facing design within an area of continuous retaining walls.
- Provide drawings for review indicating the proposed design arrangement when proposing the use of 2 or more systems.
- 3.3. Working Drawings. When proprietary wall systems are used for permanent or temporary walls, submit casting drawings, construction drawings, and design calculations bearing the seal of a licensed professional engineer for review and approval following the Department's *Guide to Electronic Shop Drawing Submittal* process. Upon completion of construction, submit a set of reproducible as-built drawings.
- 3.3.1. Casting Drawings. Include all information necessary for casting wall elements, including railing and coping when prefabricated. Show shape and dimensions of panels; size, quantity, and details of the reinforcing steel; quantity, type, size, and details of connection and lifting hardware; and additional necessary details.
- 3.3.2. Construction Drawings. Include a numbered panel layout showing horizontal and vertical alignment of the walls as well as the existing and proposed groundlines. Include all information needed to erect the walls, including the proposed leveling pad elevations; the type and details of the soil reinforcing system (if applicable); the details and manufacturer of all pads, fillers, and filter fabric; the limits and dimensions of structural backfill; details necessary to incorporate coping, railing, inlets, drainage, and electrical conduit; and additional necessary details.
- Leveling pad elevations may vary from the elevations shown on the plans. Provide at least 1 ft. of cover from the top of the leveling pad to finish grade unless a different minimum cover or a specified minimum leveling pad elevation is shown.
- 3.3.3. Design Calculations. Include calculations covering the range of heights and loading conditions on the project. Calculations for both internal and external stability as described on the plans will be required. Include a summary of all design parameters used; material types, strength values, and assumed allowables; loads and loading combinations; and factor-of-safety parameters.
- 3.4. Permanent MSE Walls. Grade the foundation for the structure level to a width equal or exceeding the length of the reinforcing system. Perform proof rolling on retaining wall foundation area to identify any loose, soft, or unsuitable materials in accordance with Item 216, "Proof Rolling." Material not meeting a maximum rut depth of 1 in. per pass of pneumatic tire roller should continue to be rolled or removed and replaced with suitable material. Pneumatic tire rolling will be waived for portions of wall with a reinforcement length of 8'; for these conditions proof rolling will be required with a smooth-wheeled vibratory roller or other approved roller.
- Place drilled shafts and piling located within the MSE volume before construction of the wall. Place any required pipe underdrain before construction of the wall. Complete MSE wall construction before construction of abutment caps and abutment wing walls. Completion of walls and abutment should be in conjunction with project phasing or to allow for completion of walls that meets the proper placement and compaction at abutments.
- Place the concrete leveling pad as shown on the construction drawings. Provide a wood float finish, and wait a minimum of 24 hr. before beginning panel erection. No curing or strength testing of the leveling pad concrete is required.
- Shim the first row of panels as necessary to achieve correct alignment. Use plastic shims or other material that will not deteriorate. Remove and replace the leveling pad or provide a grout level-up as directed if the required shim height exceeds 1 in.
- Place filter fabric behind the wall along the joint between the leveling pad and the panels. Grout areas where filter fabric spans more than 6 in. at leveling pad steps.

Place and compact fill material over the leveling pad to an elevation even with or above the surrounding ground after backfilling the first row of panels. Do not allow water to accumulate and stand at the base of the wall.

Place filter fabric behind all wall joints and at the intersection of retaining walls with other structures, including riprap. Cover joints at least 6 in. on each side and use adhesive to hold the filter fabric in place.

Exercise care while lifting, setting, and aligning panels to prevent damage to the panels. Discontinue any operation that results in chipping, spalling, or cracking of panels. Remove and replace damaged panels, or repair as approved by the Engineer.

Provide external bracing for the initial row of panels. Use wooden wedges, clamps, or other means necessary to maintain position and stability of panels during placement and compaction of backfill. Remove wooden wedges as soon as the panel or coping above the wedged element is erected and backfilled. Remove all wedges after completing the wall.

Review plumbness and position of each row of panels before placing the subsequent row. Remove and rebuild any portion of the wall that is out of tolerance. Modify panel batter and bracing, and backfill material, placement, and compaction methods as required to maintain wall tolerances.

Construct walls to a local vertical and horizontal alignment tolerance of 3/4 in. when measured along a 10-ft. straightedge relative to vertical and horizontal wall control line. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 1/2 in. per 10 ft. of wall height. Construct walls so the maximum offset at any panel joint is between 3/8 in. and 3/4 in. and no joint is open to the extent the filter fabric is visible from the front of the wall.

Place backfill to closely follow the erection of each row of panels. Place the select and embankment backfill to the same elevation where possible, and operate the compaction equipment over the interface. Do not create a continuous, distinct, vertical joint between the select and embankment backfill. Complete the embankment after construction of the retaining wall.

Maintain the stability of the interface area between the existing ground and the select fill when building a wall against existing ground. Remove and recompact any material that loosens, caves, or fails.

Compact backfill to provide at least 95% of density determined in accordance with [Tex-114-E](#). Field density determination will be made in accordance with [Tex-115-E](#).

Sprinkle backfill as required to ensure adequate uniformly distributed moisture in each lift before and during compaction. Place fill in lifts of 8 in. or less (loose measurement). Place fill in a manner that avoids segregation of the fill. Decrease the lift thickness if necessary to obtain the required compaction. Use hand-operated or walk-behind compaction equipment in the 3 ft. wide strip adjacent to the wall panels. Do not displace panels or distort or damage the reinforcement system during compaction. Modify backfill material, placement, and compaction methods as necessary to meet density requirements while maintaining wall tolerances.

Place rock backfill or material the Engineer determines too coarse for density testing in accordance with Section 132.3.4.1., "Ordinary Compaction."

Place and compact the backfill to the reinforcement level, at each earth reinforcement level, before placing the reinforcement. Place earth reinforcements perpendicular to the face of the wall. Remove slack in connections before placing backfill. Pre-tension each layer of reinforcement to remove slack before placing backfill for systems using nonmetallic earth reinforcements. Use devices capable of mechanically applying and holding the required force. Do not operate tracked equipment directly on any reinforcement.

Cover the rock backfill with filter fabric before placing the 2 ft. of backfill immediately below the pavement structure or top of wall when rock backfill is used. Overlap the fabric at least 18 in. at splices, and extend it past the edge of the rock backfill at least 18 in. Use backfill that contains sufficient fines to fill the voids in a

compacted state above the filter fabric. Place a horizontal layer of filter fabric as noted above when transitioning from rock backfill to finer grained backfill anywhere within the wall volume.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace any portion of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.5. Temporary MSE Walls. Provide a facing system rigid enough to maintain a smooth and straight wall face both during and after construction.

Grade and compact the foundation for the structure as described in Section 423.3.4., "Permanent MSE Walls."

Place earth reinforcement and facing system in accordance with the approved working drawings. Backfill the 2-ft. zone immediately behind the facing with clean, coarse rock meeting the requirements of Coarse Aggregate Grade 1, 2, or 3 of Item 421, "Hydraulic Cement Concrete," or of Type DS backfill as described in Section 423.2.4.2., "Select." Cement-stabilized backfill as described in Section 423.2.4.4., "Cement-Stabilized Backfill," may be used in place of the coarse rock.

Place and compact backfill in accordance with Section 423.3.4., "Permanent MSE Walls."

Construct walls to a vertical and horizontal alignment tolerance of 3 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 2 in. per 10 ft. of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements and filter fabric with no gaps in the facing or fabric.

Prevent surface water or rainwater from damaging the retaining walls during and after construction. Place temporary berms or curbs, shape the backfill, or use other approved methods to prevent water from flowing against or over the wall face. Remove and replace any portion of the wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.6. Concrete Block Retaining Walls. The concrete block units may be sampled and tested by the Engineer before shipment or upon delivery to the construction site. Display for approval, samples of block units indicating the color, texture, and finish. Store, transport, and handle all block units carefully to prevent cracking or damage.

Grade and compact the foundation for the structure, and place the leveling pad as described in Section 423.3.4., "Permanent MSE Walls."

Place the concrete block facing units in accordance with the approved working drawings. Fill the voids within the units and fill the 1-ft. zone immediately behind the facing with drainage aggregate as described in Section 423.2.4.3., "Drainage Aggregate." Systems tested without unit fill may omit the fill as indicated on the approved drawings. Systems with approved filter fabric details may omit the drainage aggregate in the 1-ft. zone immediately behind the facing.

Place reinforcements and backfill for walls using earth reinforcements in accordance with the requirements of Section 423.3.4., "Permanent MSE Walls." Pay particular attention to the connection details of the earth reinforcements to the concrete block units.

Construct walls to a vertical and horizontal alignment tolerance of 1-1/2 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (deviation from the vertical or battered control line, top to bottom) of 1 in. per 10 feet of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements with maximum 1/4-in. gaps between block units.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace all portions of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

4. MEASUREMENT

This Item will be measured by the square foot of the front surface area of the wall. Unless otherwise shown on the plans, the area will be measured from 1 ft. below finished grade of the ground line on the face of the exterior wall to the top of the wall including any coping required (not including railing).

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Retaining Walls" of the type or special surface finish specified. This price is full compensation for excavation in back of retaining walls and for footings; furnishing and placing footings, leveling pads, copings, and traffic railing foundations; furnishing, placing, and compacting backfill (except in embankment areas), including cement for stabilization; proof rolling; furnishing and placing concrete, reinforcing steel, waterproofing material, filter material and drain pipe, joint material, water stop, and filter fabric when required; fabricating, curing, and finishing all panels; furnishing and placing earth reinforcement, anchorage systems, and fasteners; wall erection; and equipment, labor, tools, and incidentals.

Retaining wall backfill areas that are also in embankment areas will be considered part of the quantities measured and paid for under Item 132, "Embankment."

When drilled shafts are required, they will be measured and paid for as specified in Item 416, "Drilled Shaft Foundations." When piling is required, it will be measured and paid for as specified on the plans for piling of the appropriate type.

Item 440

Reinforcement for Concrete



1. DESCRIPTION

Furnish and place reinforcement of the type, size, and details shown on the plans.

2. MATERIALS

Use deformed steel bar reinforcement unless otherwise specified or allowed.

- 2.1. Approved Mills. Before furnishing steel, producing mills of reinforcing steel for the Department must be pre-approved in accordance with [DMS-7320](#), "Qualification Procedure for Reinforcing Steel Producing Mills," by the Construction Division. The Department's MPL has a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

Contact the Construction Division with the name and location of the producing mill for stainless reinforcing steel, low carbon/chromium reinforcing steel, or dual-coated reinforcing steel at least 4 weeks before ordering any material.

- 2.2. Deformed Steel Bar Reinforcement. Provide deformed reinforcing steel conforming to one of the following:

- ASTM A615, Grades 60, 75, or 80;
- ASTM A996, Type A, Grade 60;
- ASTM A996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A706, Grades 60 or 80.

Provide the grade of reinforcing steel shown on the plans. Provide Grade 60 if no grade is shown.

The nominal size, area, and weight of reinforcing steel bars this Item covers are shown in Table 1.

Table 1
Size, Area, and Weight of Reinforcing Steel Bars

Bar Size Number (in.)	Diameter (in.)	Area (sq. in.)	Weight per Foot (lbs.)
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.650
18	2.257	4.00	13.60

- 2.3. Smooth Steel Bar Reinforcement. Provide smooth bars for concrete pavement with a yield strength of at least 60 ksi and meeting ASTM A615. Provide steel conforming to ASTM A615 or meet the physical requirements of ASTM A36 for smooth bars that are larger than No. 3. Designate smooth bars by size number up to No. 4 and by diameter in inches above No. 4.

- 2.4. Spiral Reinforcement. Provide bars or wire for spiral reinforcement of the grade and minimum size or gauge shown on the plans.

Provide smooth or deformed wire conforming to ASTM A1064. Provide bars conforming to ASTM A615; ASTM A996, Type A; or ASTM A675, Grade 80, meeting dimensional requirements of ASTM A615.

- 2.5. Weldable Reinforcing Steel. Provide reinforcing steel conforming to ASTM A706 or with a maximum carbon equivalent (C.E.) of 0.55% if welding of reinforcing steel is required or desired. Provide a report showing the percentages of elements necessary to establish C.E. for reinforcing steel that does not meet ASTM A706, in order to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Section 448.4.2.1.1., "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

Do not weld stainless reinforcing steel without permission from the Engineer. Provide stainless reinforcing steel suitable for welding, if required, and submit welding procedures and electrodes to the Engineer for approval.

- 2.6. Welded Wire Reinforcement. Provide welded wire reinforcement (WWR) conforming to ASTM A1064. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W."

Designate WWR as shown in the following example: 6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Table 2
Wire Size Number, Diameter, and Area

Size Number (in.)	Diameter (in.)	Area (sq. in.)
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
2.9	0.192	0.035
2.5	0.178	0.025
2	0.160	0.020
1.4	0.134	0.014
1.2	0.124	0.012
0.5	0.080	0.005

Note—Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Fractional sizes between the sizes listed above are also available and acceptable for use.

- 2.7. Epoxy Coating. Provide epoxy coated reinforcing steel as shown on the plans. Before furnishing epoxy coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with [DMS-7330](#), "Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators." The Department's MPL has a list of approved applicators.

Furnish coated reinforcing steel meeting the requirements in Table 3.

Table 3
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or WWR	ASTM A884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with [DMS-8130](#), "Epoxy Powder Coating for Reinforcing Steel." Patch no more than 1/4-in. total length in any foot at the applicator's plant.

Maintain identification of all reinforcing steel throughout the coating and fabrication process and until delivery to the project site.

Furnish 1 copy of a written certification verifying the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

- 2.8. Mechanical Couplers. Use couplers of the type specified in [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel," Article 4510.5.A, "General Requirements," when mechanical splices in reinforcing steel bars are shown on the plans.

Furnish only couplers pre-qualified in accordance with [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel." Ensure sleeve-wedge type couplers are not used on coated reinforcing. Sample and test couplers for use on individual projects in accordance with [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel." Furnish couplers only at locations shown on the plans.

Furnish couplers for stainless reinforcing steel with the same alloy designation as the reinforcing steel.

- 2.9. Fibers. Supply fibers conforming to [DMS-4550](#) "Fibers for Concrete" at the minimum dosage listed in the Department's MPL, when allowed by the plans. Use non-metallic fibers when shown on the plans.

- 2.10. Stainless Reinforcing Steel. Provide deformed steel bars of the types listed in Table 4 and conforming to ASTM A955, Grade 60 or higher when stainless reinforcing steel is required on the plans.

Table 4
Acceptable Types of Deformed Stainless Steel Bar

UNS Designation	S31653	S31803	S24100	S32304
AISI Type	316LN	2205	XM-28	2304

- 2.11. Low Carbon/Chromium Reinforcing Steel. Provide deformed steel bars conforming to ASTM A1035, Grade 100 when low carbon/chromium reinforcing steel is required on the plans.

- 2.12. Dual-Coated Reinforcing Steel. Provide deformed bars conforming to ASTM A1055, Grade 60 or higher when dual-coated reinforcing steel is required on the plans.

- 2.13. Glass Fiber Reinforced Polymer Bars (GFRP). Provide bars conforming to the AASHTO LRFD *Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings*, Section 4, "Material Specifications" when GFRP bars are required on the plans. Provide sample certification demonstrating the GFRP bar supplier has produced bar that meets the Material Specifications 2 mo. before fabrication. Furnish certification upon shipment that the GFRP bar supplied meets the Material Specifications.

3. CONSTRUCTION

- 3.1. Bending. Fabricate reinforcing steel bars as prescribed in the CRSI *Manual of Standard Practice* to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the Department. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 5.

Table 5
Minimum Inside Diameter of Bar Bends

Bend	Bar Size Number (in.)	Pin Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	4d
	6, 7, 8	6d
Bends in main bars and in secondary bars not covered above	3 through 8	6d
	9, 10, 11	8d
	14, 18	10d

Bend-test representative specimens as described for smaller bars in the applicable ASTM specification where bending No. 14 or No. 18 Grade 60 bars is required. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

Bend stainless reinforcing steel in accordance with ASTM A955.

- 3.2. Tolerances. Fabrication tolerances for bars are shown in Figure 1.

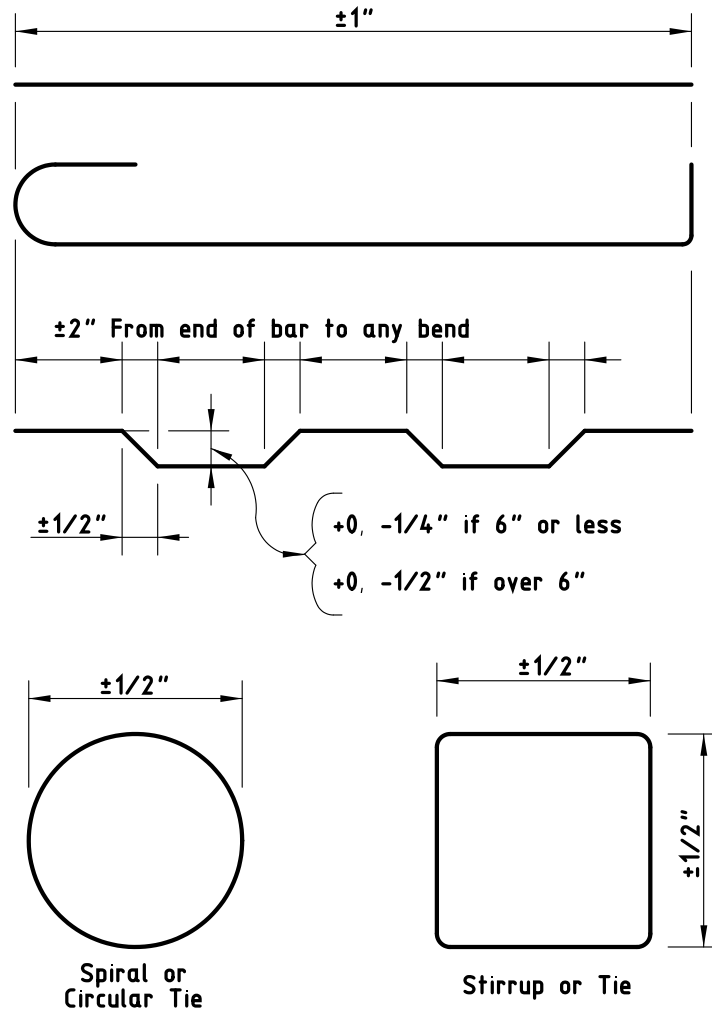


Figure 1
Fabrication Tolerances for Bars

- 3.3. Storage. Store reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

Do not allow stainless reinforcing steel to be in direct contact with uncoated reinforcing steel, nor with galvanized reinforcing steel. This does not apply to stainless steel wires and ties. Store stainless reinforcing steel separately, off the ground on wooden supports.

- 3.4. Splices. Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs no more than 15 in. in thickness, columns, walls, and parapets.
- Do not splice bars less than 30 ft. in plan length unless otherwise approved. For bars exceeding 30 ft. in plan length, the distance center-to-center of splices must be at least 30 ft. minus 1 splice length, with no more than 1 individual bar length less than 10 ft. Make lap splices not shown on the plans, but otherwise

permitted, in accordance with Table 6. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

Table 6
Minimum Lap Requirements for Steel Bar Sizes through No. 11

Bar Size Number (in.)	Uncoated Lap Length	Coated Lap Length
3	1 ft. 4 in.	2 ft. 0 in.
4	1 ft. 9 in.	2 ft. 8 in.
5	2 ft. 2 in.	3 ft. 3 in.
6	2 ft. 7 in.	3 ft. 11 in.
7	3 ft. 5 in.	5 ft. 2 in.
8	4 ft. 6 in.	6 ft. 9 in.
9	5 ft. 8 in.	8 ft. 6 in.
10	7 ft. 3 in.	10 ft. 11 in.
11	8 ft. 11 in.	13 ft. 5 in.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice WWR using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 6 are permitted.
- Lap the existing longitudinal bars with the new bars as shown in Table 6 for box culvert extensions with less than 1 ft. of fill. Lap at least 1 ft. 0 in. for extensions with more than 1 ft. of fill.
- Ensure welded splices conform to the requirements of the plans and of Item 448, "Structural Field Welding." Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.
- Install mechanical coupling devices in accordance with the manufacturer's recommendations at locations shown on the plans. Protect threaded male or female connections, and ensure the threaded connections are clean when making the connection. Do not repair damaged threads.
- Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

3.5.

Placing. Place reinforcement as near as possible to the position shown on the plans. Do not vary bars from plan placement by more than 1/12 of the spacing between bars in the plane of the bar parallel to the nearest surface of concrete. Do not vary bars from plan placement by more than 1/4 in. in the plane of the bar perpendicular to the nearest surface of concrete. Provide a minimum 1-in. clear cover of concrete to the nearest surface of bar unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is -0, +1/2 in.

Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and keep the reinforcement at the proper distance from the forms. Provide bar supports in accordance with the *CRSI Manual of Standard Practice*. Use Class 1 supports, approved plastic bar supports, precast mortar, or concrete blocks when supports are in contact with removable or stay-in-place forms. Use Class 3 supports in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

Use Class 1A supports with epoxy coated reinforcing steel. Provide epoxy or plastic coated tie wires and clips for use with epoxy coated reinforcing steel.

Use mortar or concrete with a minimum compressive strength of 5,000 psi for precast bar supports. Provide a suitable tie wire in each block for anchoring to the bar.

Place individual bar supports in rows at 4-ft. maximum spacing in each direction. Place continuous type bar supports at 4-ft. maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and storm drains is not cause for rejection.

Tie reinforcement for bridge slabs and top slabs of direct traffic culverts at all intersections, except tie only alternate intersections where spacing is less than 1 ft. in each direction. Tie the bars at enough intersections to provide a rigid cage of reinforcement for reinforcement cages for other structural members. Fasten mats of WWR securely at the ends and edges.

Clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement before concrete placement. Do not place concrete until authorized.

Stop placement until corrective measures are taken if reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement.

3.6. Handling, Placing, and Repairing Epoxy Coated Reinforcing Steel.

3.6.1. Handling. Provide systems for handling coated reinforcing steel with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.

3.6.2. Placing. Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 440.3.6.3., "Repairing Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6 in. beyond the weld limits before welding and 2 in. beyond the limits of the coupler before assembly. Clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish after welding or coupling. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

Coat the splice area after cleaning with epoxy repair material to a thickness of 7 to 17 mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3.6.3. Repairing Coating. Use material that complies with the requirements of this Item and ASTM D3963 for repairing of the coating. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. Apply at least the same coating thickness as required for the original coating for areas to be patched. Repair all visible damage to the coating.

Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure they are free from surface contaminants. Make repairs in the shop or field as required.

3.7. Handling and Placing Stainless Reinforcing Steel. Handle, cut, and place stainless reinforcing steel bar using tools that are not used on carbon steel. Do not use carbon steel tools, chains, slings, etc. when handling stainless steel. Use only nylon or polypropylene slings. Cut stainless steel reinforcing using shears, saws, abrasive cutoff wheels, or torches. Remove any thermal oxidation using pickling paste. Do not field bend stainless steel reinforcing without approval.

Use 16 gauge fully annealed stainless steel tie wire conforming to the material properties listed in Section 440.2.10., "Stainless Reinforcing Steel." Support all stainless reinforcing steel on solid plastic, stainless steel, or epoxy coated steel chairs. Do not use uncoated carbon steel chairs in contact with stainless reinforcing steel.

- 3.8. Bending, Handling, Repairing, and Placing GFRP Bars. Fabricate, handle, repair, and place GFRP bars in accordance with the AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings, Section 5, Construction Specifications.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

Item 502

Barricades, Signs, and Traffic Handling



1.	DESCRIPTION Provide, install, move, replace, maintain, clean, and remove all traffic control devices shown on the plans and as directed.
2.	CONSTRUCTION Comply with the requirements of Article 7.2., "Safety." Implement the traffic control plan (TCP) shown on the plans. Install traffic control devices straight and plumb. Make changes to the TCP only as approved. Minor adjustments to meet field conditions are allowed. Submit Contractor-proposed TCP changes, signed and sealed by a licensed professional engineer, for approval. The Engineer may develop, sign, and seal Contractor-proposed changes. Changes must conform to guidelines established in the TMUTCD using approved products from the Department's Compliant Work Zone Traffic Control Device List. Maintain traffic control devices by taking corrective action when notified. Corrective actions include, but are not limited to, cleaning, replacing, straightening, covering, and removing devices. Maintain the devices such that they are properly positioned and spaced, legible, and have retroreflective characteristics that meet requirements day or night and in all weather conditions. The Engineer may authorize or direct in writing the removal or relocation of project limit advance warning signs. When project limit advance warning signs are removed before final acceptance, provide traffic control in accordance with the TMUTCD for minor operations as approved. Remove all traffic control devices upon completion of the work as shown on the plans or as directed.
3.	MEASUREMENT Barricades, Signs, and Traffic Handling will be measured by the month. Law enforcement personnel with patrol vehicles will be measured by the hour for each person.
4.	PAYMENT 4.1. Barricades, Signs, and Traffic Handling. Except for Contracts with callout work and work orders, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals.

When the plans establish pay items for particular work in the TCP, that work will be measured and paid under pertinent Items.

- 4.1.1. Initiation of Payment. Payment for this Item will begin on the first estimate after barricades, signs, and traffic handling devices have been installed in accordance with the TCP and construction has begun.
- 4.1.2. Paid Months. Monthly payment will be made each succeeding month for this Item provided the barricades, signs, and traffic handling devices have been installed and maintained in accordance with the TCP until the Contract amount has been paid.

If, within the time frame established by the Engineer, the Contractor fails to provide or properly maintain signs and barricades in compliance with the Contract requirements, as determined by the Engineer, the Contractor will be considered in noncompliance with this Item. No payment will be made for the months in question, and the total final payment quantity will be reduced by the number of months the Contractor was in noncompliance.
- 4.1.3. Maximum Total Payment Before Acceptance. The total payment for this Item will not exceed 10% of the total Contract amount before final acceptance in accordance with Article 5.12., "Final Acceptance." The remaining balance will be paid in accordance with Section 502.4.1.5., "Balance Due."
- 4.1.4. Total Payment Quantity. The quantity paid under this Item will not exceed the total quantity shown on the plans except as modified by change order and as adjusted by Section 502.4.1.2., "Paid Months." An overrun of the plans quantity for this Item will not be allowed for approving designs; testing; material shortages; closed construction seasons; curing periods; establishment, performance, test, and maintenance periods; failure to complete the work in the number of months allotted; nor delays caused directly or indirectly by requirements of the Contract.
- 4.1.5. Balance Due. The remaining unpaid months of barricades less non-compliance months will be paid on final acceptance of the project, if all work is complete and accepted in accordance with Article 5.12., "Final Acceptance."
- 4.1.6. Contracts with Callout Work and Work Orders. The work performed and the materials furnished with this Item and measured as provided under "Measurement," will be considered subsidiary to pertinent Items, except for federally funded Contracts.
- 4.2. Law Enforcement Personnel. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid by Contractor force account for "Law Enforcement Personnel." This price is full compensation for furnishing all labor, materials, supplies, equipment, patrol vehicle, fees, and incidentals necessary to complete the work as directed.

Item 506

Temporary Erosion, Sedimentation, and Environmental Controls



1. DESCRIPTION

Install, maintain, and remove erosion, sedimentation, and environmental control measures to prevent or reduce the discharge of pollutants in accordance with the Storm Water Pollution Prevention Plan (SWP3) on the plans and the Texas Pollutant Discharge Elimination System (TPDES) General Permit TXR150000. Control measures are defined as Best Management Practices used to prevent or reduce the discharge of pollutants. Control measures include, but are not limited to, rock filter dams, temporary pipe slope drains, temporary paved flumes, construction exits, earthwork for erosion control, pipe, construction perimeter fence, sandbags, temporary sediment control fence, biodegradable erosion control logs, vertical tracking, temporary or permanent seeding, and other measures. Erosion and sediment control devices must be selected from the *Erosion Control Approved Products* or *Sediment Control Approved Products* lists. Perform work in a manner to prevent degradation of receiving waters, facilitate project construction, and comply with applicable federal, state, and local regulations. Ensure the installation and maintenance of control measures is performed in accordance with the manufacturer's or designer's specifications.

Provide the Contractor Certification of Compliance before performing SWP3 or soil disturbing activities. By signing the Contractor Certification of Compliance, the Contractor certifies they have read and understand the requirements applicable to this project pertaining to the SWP3, the plans, and the TPDES General Permit TXR150000. The Contractor is responsible for any penalties associated with non-performance of installation or maintenance activities required for compliance. Ensure the most current version of the certificate is executed for this project.

2. MATERIALS

Furnish materials in accordance with the following:

- Item 161, "Compost,"
- Item 432, "Riprap," and
- Item 556, "Pipe Underdrains."

2.1. Rock Filter Dams.

2.1.1. Aggregate. Furnish aggregate with approved hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding. Provide the following:

- Types 1, 2, and 4 Rock Filter Dams. Use 3 to 6 in. aggregate.
- Type 3 Rock Filter Dams. Use 4 to 8 in. aggregate.

2.1.2. Wire. Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:

- a double-twisted, hexagonal weave with a nominal mesh opening of 2-1/2 × 3-1/4 in.;
- minimum 0.0866 in. steel wire for netting;
- minimum 0.1063 in. steel wire for selvages and corners; and
- minimum 0.0866 in. for binding or tie wire.

2.1.3. Sandbag Material. Furnish sandbags meeting Section 506.2.8., "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.

- 2.2. Temporary Pipe Slope Drains. Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections that conform to the plans. Recycled and other materials meeting these requirements are allowed if approved.
- Furnish concrete in accordance with Item 432, "Riprap."
- 2.3. Temporary Paved Flumes. Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material that conforms to the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of 1/2 cu. ft. for the construction of energy dissipaters.
- 2.4. Construction Exits. Provide materials that meet the details shown on the plans and this Section.
- 2.4.1. Rock Construction Exit. Provide crushed aggregate for long- and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials, and organic and injurious matter. Use 4- to 8-in. aggregate for Type 1. Use 2- to 4-in. aggregate for Type 3.
- 2.4.2. Timber Construction Exit. Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers with nuts and bolts or lag bolts, of at least 1/2 in. diameter, unless otherwise shown on the plans or allowed. Provide plywood or pressed wafer board at least 1/2 in. thick for short-term exits.
- 2.4.3. Foundation Course. Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.
- 2.5. Embankment for Erosion Control. Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.
- 2.6. Pipe. Provide pipe outlet material in accordance with Item 556, "Pipe Underdrains," and details shown on the plans.
- 2.7. Construction Perimeter Fence.
- 2.7.1. Posts. Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in., or use nominal 2 × 4 in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/5 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
- 2.7.2. Fence. Provide orange construction fencing as approved.
- 2.7.3. Fence Wire. Provide 14 gauge or larger galvanized smooth or twisted wire. Provide 16 gauge or larger tie wire.
- 2.7.4. Flagging. Provide brightly-colored flagging that is fade-resistant and at least 3/4 in. wide to provide maximum visibility both day and night.
- 2.7.5. Staples. Provide staples with a crown at least 1/2 in. wide and legs at least 1/2 in. long.
- 2.7.6. Used Materials. Previously used materials meeting the applicable requirements may be used if approved.
- 2.8. Sandbags. Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70%.
- Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags. Filled sandbags must be 24 to 30 in. long, 16 to 18 in. wide, and 6 to 8 in. thick.

Table 1
Sand Gradation

Sieve Size	Retained (% by Weight)
#4	Maximum 3%
#100	Minimum 80%
#200	Minimum 95%

Aggregate may be used instead of sand for situations where sandbags are not adjacent to traffic. The aggregate size must not exceed 3/8 in.

- 2.9. Temporary Sediment Control Fence. Provide a net-reinforced fence using woven geo-textile fabric. Logos visible to the traveling public will not be allowed.
- 2.9.1. Fabric. Provide fabric materials in accordance with [DMS-6230](#), "Temporary Sediment Control Fence Fabric."
- 2.9.2. Posts. Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Furnish soft wood posts at least 3 in. in diameter, or use nominal 2 × 4 in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/2 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
- 2.9.3. Net Reinforcement. Provide net reinforcement of at least 12.5 gauge (SWG) galvanized welded wire mesh, with a maximum opening size of 2 × 4 in., at least 24 in. wide, unless otherwise shown on the plans.
- 2.9.4. Staples. Provide staples with a crown at least 3/4 in. wide and legs 1/2 in. long.
- 2.9.5. Used Materials. Use recycled material meeting the applicable requirements if approved.
- 2.10. Biodegradable Erosion Control Logs.
- 2.10.1. Core Material. Furnish core material that is biodegradable or recyclable. Use compost, mulch, aspen excelsior wood fibers, chipped site vegetation, agricultural rice or wheat straw, coconut fiber, 100% recyclable fibers, or any other acceptable material unless specifically called out on the plans. Permit no more than 5% of the material to escape from the containment mesh. Furnish compost meeting the requirements of Item 161, "Compost."
- 2.10.2. Containment Mesh. Furnish containment mesh that is 100% biodegradable, photodegradable, or recyclable such as burlap, twine, UV photodegradable plastic, polyester, or any other acceptable material.

Furnish biodegradable or photodegradable containment mesh when log will remain in place as part of a vegetative system.

Furnish recyclable containment mesh for temporary installations.
- 2.10.3. Size. Furnish biodegradable erosion control logs with diameters shown on the plans or as directed. Stuff containment mesh densely so logs do not deform.

3. QUALIFICATIONS, TRAINING, AND EMPLOYEE REQUIREMENTS

- 3.1. Contractor Responsible Person Environmental (CRPE) Qualifications and Responsibilities. Provide and designate in writing at the preconstruction conference a CRPE and alternate CRPE who have overall responsibility for the storm water management program. The CRPE will implement storm water and erosion control practices; will oversee and observe storm water control measure monitoring and management; will monitor the project site daily and produce daily monitoring reports as long as there are BMPs in place or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES General Permit TXR150000. During time suspensions when work is not occurring or on contract non-work days, daily inspections are not required unless a rain event has occurred. The CRPE will provide recommendations on

how to improve the effectiveness of control measures. Attend the Department's preconstruction conference for the project. Ensure training is completed as identified in Section 506.3.3., "Training," by all applicable personnel before employees work on the project. Document and submit a list, signed by the CRPE, of all applicable Contractor and subcontractor employees who have completed the training. Include the employee's name, the training course name, and date the employee completed the training. Provide the most current list at the preconstruction conference or before SWP3 or soil disturbing activities. Update the list as needed and provide the updated list when updated.

- 3.2. Contractor Superintendent Qualifications and Responsibilities. Provide a superintendent that is competent, has experience with and knowledge of storm water management, and is knowledgeable of the requirements and the conditions of the TPDES General Permit TXR150000. The superintendent will manage and oversee the day to day operations and activities at the project site; work with the CRPE to provide effective storm water management at the project site; represent and act on behalf of the Contractor; and attend the Department's preconstruction conference for the project.
- 3.3. Training. All Contractor and subcontractor employees involved in soil disturbing activities, small or large structures, storm water control measures, and seeding activities must complete training as prescribed by the Department.

4. CONSTRUCTION

- 4.1. Contractor Responsibilities. Implement the SWP3 for the project site in accordance with the plans and specifications, TPDES General Permit TXR150000, and as directed. Coordinate storm water management with all other work on the project. Develop and implement an SWP3 for project-specific material supply plants within and outside of the Department's right of way in accordance with the specific or general storm water permit requirements. Prevent water pollution from storm water associated with construction activity from entering any surface water or private property on or adjacent to the project site.
- 4.2. Implementation. The CRPE, or alternate CRPE, must be accessible by phone and able to respond to project-related storm water management or other environmental emergencies 24 hr. per day.
 - 4.2.1. Commencement. Implement the SWP3 as shown and as directed. Contractor-proposed recommendations for changes will be allowed as approved. Conform to the established guidelines in the TPDES General Permit TXR150000 to make changes. Do not implement changes until approval has been received and changes have been incorporated into the plans. Minor adjustments to meet field conditions are allowed and will be recorded in the SWP3.
 - 4.2.2. Phasing. Implement control measures before the commencement of activities that result in soil disturbance. Phase and minimize the soil disturbance to the areas shown on the plans. Coordinate temporary control measures with permanent control measures and all other work activities on the project to assure economical, effective, safe, and continuous water pollution prevention. Provide control measures that are appropriate to the construction means, methods, and sequencing allowed by the Contract. Exercise precaution throughout the life of the project to prevent pollution of ground waters and surface waters. Schedule and perform clearing and grubbing operations so that stabilization measures will follow immediately thereafter if project conditions permit. Bring all grading sections to final grade as soon as possible and implement temporary and permanent control measures at the earliest time possible. Implement temporary control measures when required by the TPDES General Permit TXR150000 or otherwise necessitated by project conditions.

Do not prolong final grading and shaping. Preserve vegetation where possible throughout the project, and minimize clearing, grubbing, and excavation within stream banks, bed, and approach sections.
- 4.3. General.
 - 4.3.1. Temporary Alterations or Control Measure Removal. Altering or removal of control measures is allowed when control measures are restored within the same working day.

- 4.3.2. Stabilization. Initiate stabilization for disturbed areas no more than 14 days after the construction activities in that portion of the site have temporarily or permanently ceased. Establish a uniform vegetative cover or use another stabilization practice in accordance with the TPDES General Permit TXR150000.
- 4.3.3. Finished Work. Remove and dispose of all temporary control measures upon acceptance of vegetative cover or other stabilization practice unless otherwise directed. Complete soil disturbing activities and establish a uniform perennial vegetative cover. A project will not be considered for acceptance until a vegetative cover of 70% density of existing adjacent undisturbed areas is obtained or equivalent permanent stabilization is obtained in accordance with the TPDES General Permit TXR150000. An exception will be allowed in arid areas as defined in the TPDES General Permit TXR150000.
- 4.3.4. Restricted Activities and Required Precautions. Do not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens, or any other petroleum product. Operate and maintain equipment on-site to prevent actual or potential water pollution. Manage, control, and dispose of litter on-site such that no adverse impacts to water quality occur. Prevent dust from creating a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property. Wash out concrete trucks only as described in the TPDES General Permit TXR150000. Use appropriate controls to minimize the offsite transport of suspended sediments and other pollutants if it is necessary to pump or channel standing water (i.e., dewatering). Prevent discharges that would contribute to a violation of Edwards Aquifer Rules, water quality standards, the impairment of a listed water body, or other state or federal law.
- 4.4. Installation, Maintenance, and Removal Work. Perform work in accordance with the SWP3, according to manufacturers' guidelines, and in accordance with the TPDES General Permit TXR150000. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until soil disturbing activities are completed and permanent erosion control features are in place or the disturbed area has been adequately stabilized as approved.
- The Department will inspect and document the condition of the control measures at the frequency shown on the plans and will provide the Construction SWP3 Field Inspection and Maintenance Reports to the Contractor. Make corrections as soon as possible before the next anticipated rain event or within 7 calendar days after being able to enter the worksite for each control measure. The only acceptable reason for not accomplishing the corrections with the time frame specified is when site conditions are "Too Wet to Work." Take immediate action if a correction is deemed critical as directed. When corrections are not made within the established time frame, all work will cease on the project and time charges will continue while the control measures are brought into compliance. Commence work once the Engineer reviews and documents the project is in compliance. Commencing work does not release the Contractor of the liability for noncompliance of the SWP3, plans, or TPDES General Permit TXR150000.
- The Engineer may limit the disturbed area if the Contractor cannot control soil erosion and sedimentation resulting from the Contractor's operations. Implement additional controls as directed.
- Remove devices upon approval or as directed. Finish-grade and dress the area upon removal. Stabilize disturbed areas in accordance with the permit, and as shown on the plans or directed. Materials removed are considered consumed by the project. Retain ownership of stockpiled material and remove it from the project when new installations or replacements are no longer required.
- 4.4.1. Rock Filter Dams for Erosion Control. Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option.

Place the aggregate to the lines, height, and slopes specified, without undue voids for Types 1, 2, 3, and 5. Place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings for Types 2 and 3, or as directed. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams according to the following criteria unless otherwise shown on the plans:

- 4.4.1.1. Type 1 (Non-Reinforced).
- Height. At least 18 in. measured vertically from existing ground to top of filter dam.
 - Top Width. At least 2 ft.
 - Slopes. No steeper than 2:1.
- 4.4.1.2. Type 2 (Reinforced).
- Height. At least 18 in. measured vertically from existing ground to top of filter dam.
 - Top Width. At least 2 ft.
 - Slopes. No steeper than 2:1.
- 4.4.1.3. Type 3 (Reinforced).
- Height. At least 36 in. measured vertically from existing ground to top of filter dam.
 - Top Width. At least 2 ft.
 - Slopes. No steeper than 2:1.
- 4.4.1.4. Type 4 (Sack Gabions). Unfold sack gabions and smooth out kinks and bends. Connect the sides by lacing in a single loop–double loop pattern on 4- to 5-in. spacing for vertical filling. Pull the end lacing rod at one end until tight, wrap around the end, and twist 4 times. Fill with stone at the filling end, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires 4 times.
- Place the sack flat in a filling trough, fill with stone, connect sides, and secure ends as described above for horizontal filling.
- Lift and place without damaging the gabion. Shape sack gabions to existing contours.
- 4.4.1.5. Type 5. Provide rock filter dams as shown on the plans.
- 4.4.2. Temporary Pipe Slope Drains. Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced a maximum of 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete or rubble riprap in accordance with Item 432, "Riprap," when designated on the plans.
- 4.4.3. Temporary Paved Flumes. Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the materials specified above, to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.
- 4.4.4. Construction Exits. Prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits when tracking conditions exist. Construct exits for either long- or short-term use.
- 4.4.4.1. Long-Term. Place the exit over a foundation course as required. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.
- 4.4.4.1.1. Type 1. Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.
- 4.4.4.1.2. Type 2. Construct using railroad ties and timbers as shown on the plans or as directed.

- 4.4.4.2. Short-Term.
- 4.4.4.2.1. Type 3. Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.
- 4.4.4.2.2. Type 4. Construct as shown on the plans or as directed.
- 4.4.5. Earthwork for Erosion Control. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
- 4.4.5.1. Excavation and Embankment for Erosion Control Features. Place earth dikes, swales, or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed.

Create a sediment basin, where required, providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.
- 4.4.5.2. Excavation of Sediment and Debris. Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.
- 4.4.6. Construction Perimeter Fence. Construct, align, and locate fencing as shown on the plans or as directed.
- 4.4.6.1. Installation of Posts. Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8 to 10 ft.
- 4.4.6.2. Wire Attachment. Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.
- 4.4.6.3. Flag Attachment. Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.
- 4.4.7. Sandbags for Erosion Control. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags 1/2 the length of the preceding row. Place a single layer of sandbags downstream as a secondary debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.
- 4.4.8. Temporary Sediment-Control Fence. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, as specified in this Section, or as directed.
- 4.4.8.1. Installation of Posts. Embed posts at least 18 in. deep, or adequately anchor, if in rock, with a spacing of 6 to 8 ft. and install on a slight angle toward the runoff source.
- 4.4.8.2. Fabric Anchoring. Dig trenches along the uphill side of the fence to anchor 6 to 8 in. of fabric. Provide a minimum trench cross-section of 6 × 6 in. Place the fabric against the side of the trench and align approximately 2 in. of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.
- 4.4.8.3. Fabric and Net Reinforcement Attachment. Attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced unless otherwise shown on the plans. Sewn

vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 in. or less.

- 4.4.8.4. Fabric and Net Splices. Locate splices at a fence post with a minimum lap of 6 in. attached in at least 6 places equally spaced unless otherwise shown on the plans. Do not locate splices in concentrated flow areas.

Requirements for installation of used temporary sediment-control fence include the following:

- fabric with minimal or no visible signs of biodegradation (weak fibers),
- fabric without excessive patching (more than 1 patch every 15 to 20 ft.),
- posts without bends, and
- backing without holes.

- 4.4.9. Biodegradable Erosion Control Logs. Install biodegradable erosion control logs near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the biodegradable erosion control logs into the erosion measures used to control sediment in areas of higher flow. Install, align, and locate the biodegradable erosion control logs as specified below, as shown on the plans, or as directed.

Secure biodegradable erosion control logs in a method adequate to prevent displacement as a result of normal rain events, prevent damage to the logs, and as approved, such that flow is not allowed under the logs. Temporarily removing and replacing biodegradable erosion logs as to facilitate daily work is allowed at the Contractor's expense.

- 4.4.10. Vertical Tracking. Perform vertical tracking on slopes to temporarily stabilize soil. Provide equipment with a track undercarriage capable of producing a linear soil impression measuring a minimum of 12 in. long × 2 to 4 in. wide × 1/2 to 2 in. deep. Do not exceed 12 in. between track impressions. Install continuous linear track impressions where the 12 in. length impressions are perpendicular to the slope. Vertical tracking is required on projects where soil disturbing activities have occurred unless otherwise approved.

- 4.5. Monitoring and Documentation. Monitor the control measures on a daily basis as long as there are BMPs in place and/or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES General Permit TXR150000. During time suspensions when work is not occurring or contract non-work days, daily inspections are not required unless a rain event has occurred. Monitoring will consist of, but is not limited to, observing, inspecting, and documenting site locations with control measures and discharge points to provide maintenance and inspection of controls as described in the SWP3. Keep written records of daily monitoring. Document in the daily monitoring report the control measure condition, the date of inspection, required corrective actions, responsible person for making the corrections, and the date corrective actions were completed. Maintain records of all monitoring reports at the project site or at an approved place. Provide copies within 7 days. Together, the CRPE and an Engineer's representative will complete the Construction Stage Gate Checklist on a periodic basis as directed.

5. MEASUREMENT

- 5.1. Rock Filter Dams. Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.
- 5.1.1. Linear Measurement. When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.
- 5.1.2. Volume Measurement. When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.
- 5.1.2.1. Installation. Measurement will be made in final position.
- 5.1.2.2. Removal. Measurement will be made at the point of removal.

- 5.2. Temporary Pipe Slope Drains. Temporary pipe slope drains will be measured by the foot.
- 5.3. Temporary Paved Flumes. Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.
- 5.4. Construction Exits. Construction exits will be measured by the square yard of surface area.
- 5.5. Earthwork for Erosion and Sediment Control.
 - 5.5.1. Equipment and Labor Measurement. Equipment and labor used will be measured by the actual number of hours the equipment is operated and the labor is engaged in the work.
 - 5.5.2. Volume Measurement.
 - 5.5.2.1. In Place.
 - 5.5.2.1.1. Excavation. Excavation will be measured by the cubic yard in its original position and the volume computed by the method of average end areas.
 - 5.5.2.1.2. Embankment. Embankment will be measured by the cubic yard in its final position by the method of average end areas. The volume of embankment will be determined between:
 - the original ground surfaces or the surface upon that the embankment is to be constructed for the feature and
 - the lines, grades and slopes of the accepted embankment for the feature.
 - 5.5.2.2. In Vehicles. Excavation and embankment quantities will be combined and paid for under "Earthwork (Erosion and Sediment Control, In Vehicle)." Excavation will be measured by the cubic yard in vehicles at the point of removal. Embankment will be measured by the cubic yard in vehicles measured at the point of delivery. Shrinkage or swelling factors will not be considered in determining the calculated quantities.
- 5.6. Construction Perimeter Fence. Construction perimeter fence will be measured by the foot.
- 5.7. Sandbags for Erosion Control. Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.
- 5.8. Temporary Sediment-Control Fence. Installation or removal of temporary sediment-control fence will be measured by the foot.
- 5.9. Biodegradable Erosion Control Logs. Installation or removal of biodegradable erosion control logs will be measured by the foot along the centerline of the top of the control logs.
- 5.10. Vertical Tracking. Vertical tracking will not be measured or paid for directly but is considered subsidiary to this item.

6. PAYMENT

The following will not be paid for directly but are subsidiary to pertinent Items:

- erosion-control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter, unless a separate pay item is shown on the plans;
- repair to devices and features damaged by Contractor operations;
- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;

- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

Stabilization of disturbed areas will be paid for under pertinent Items except vertical tacking which is subsidiary.

Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly but is subsidiary to the excavation and embankment under this Item.

6.1. Rock Filter Dams. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:

6.1.1. Installation. Installation will be paid for as "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

6.1.2. Removal. Removal will be paid for as "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made at the unit price bid for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

6.2. Temporary Pipe Slope Drains. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Pipe Slope Drains" of the size specified. This price is full compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be measured and paid for under "Earthwork for Erosion and Sediment Control."

Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured and paid for in accordance with Item 432, "Riprap."

6.3. Temporary Paved Flumes. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made at the unit prices bid for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap, will be measured and paid for under "Earthwork for Erosion and Sediment Control."

- 6.4. Construction Exits. Contractor-required construction exits from off right of way locations or on-right of way PSLs will not be paid for directly but are subsidiary to pertinent Items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for construction exits needed on right of way access to work areas required by the Department will be paid for at the unit price bid for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made at the unit prices bid for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be measured and paid for under "Earthwork for Erosion and Sediment Control."

- 6.5. Earthwork for Erosion and Sediment Control.

- 6.5.1. Initial Earthwork for Erosion and Sediment Control. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Erosion and Sediment Control, In Place)," "Embankment (Erosion and Sediment Control, In Place)," "Excavation (Erosion and Sediment Control, In Vehicle)," "Embankment (Erosion and Sediment Control, In Vehicle)," or "Earthwork (Erosion and Sediment Control, In Vehicle)."

This price is full compensation for excavation and embankment including hauling, disposal of material not used elsewhere on the project; embankments including furnishing material from approved sources and construction of erosion-control features; and equipment, labor, tools, and incidentals.

Sprinkling and rolling required by this Item will not be paid for directly but will be subsidiary to this Item.

- 6.5.2. Maintenance Earthwork for Erosion and Sediment Control for Cleaning and Restoring Control Measures. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid under a Contractor Force Account Item from invoice provided to the Engineer.

This price is full compensation for excavation, embankment, and re-grading including removal of accumulated sediment in various erosion control installations as directed, hauling, and disposal of material not used elsewhere on the project; excavation for construction of erosion-control features; embankments including furnishing material from approved sources and construction of erosion-control features; and equipment, labor, tools, and incidentals.

Earthwork needed to remove and obliterate erosion-control features will not be paid for directly but is subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly but will be subsidiary to this Item.

- 6.6. Construction Perimeter Fence. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Construction Perimeter Fence." This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will be not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for "Construction Perimeter Fence," which is full compensation for the removal and reinstallation of the construction perimeter fence.

- 6.7. Sandbags for Erosion Control. Sandbags will be paid for at the unit price bid for "Sandbags for Erosion Control" (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.
- Removal of sandbags will not be paid for directly but is subsidiary to the installation item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be made at the unit price bid for "Sandbags for Erosion Control," which is full compensation for the reinstallation of the sandbags.
- 6.8. Temporary Sediment-Control Fence. The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:
- 6.8.1. Installation. Installation will be paid for as "Temporary Sediment-Control Fence (Install)." This price is full compensation for furnishing and operating equipment finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.
- 6.8.2. Removal. Removal will be paid for as "Temporary Sediment-Control Fence (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.9. Biodegradable Erosion Control Logs. The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:
- 6.9.1. Installation. Installation will be paid for as "Biodegradable Erosion Control Logs (Install)" of the size specified. This price is full compensation for furnishing and operating equipment finish backfill and grading, staking, proper disposal, labor, materials, tools, and incidentals.
- 6.9.2. Removal. Removal will be paid for as "Biodegradable Erosion Control Logs (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.10. Vertical Tracking. Vertical tracking will not be measured or paid for directly but is considered subsidiary to this item.

Item 529

Concrete Curb, Gutter, and Combined Curb and Gutter



1. DESCRIPTION

Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.

2. MATERIALS

Furnish materials conforming to:

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete or material specified on the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved.

When approved, use fibers meeting the requirements of [DMS-4550](#), "Fibers for Concrete," to replace reinforcing steel in Class A concrete. Dose fibers in accordance with the Department's MPL of pre-qualified fibers for concrete.

3. CONSTRUCTION

Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 420, "Concrete Substructures." Construct joints at locations shown on the plans. Cure for at least 72 hr.

Furnish and place reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans. Ensure that changes in curb grade and alignment do not exceed 1/4 in. between any 2 contacts on a 10-ft. straightedge.

- 3.1. Conventionally Formed Concrete. Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

Pour concrete into forms, and strike off with a template 1/4 to 3/8 in. less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.

Place curbs, gutters, and combined curb and gutters in 50-ft. maximum sections unless otherwise approved.

- 3.2. Extruded or Slipformed Concrete. Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. Coat cleaned surfaces, if required, with approved adhesive or coating at the rate of application shown on the plans or as directed. Place concrete with approved self-propelled equipment.

The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

Attach a pointer or gauge to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved.

Finish surfaces immediately after extrusion or slipforming.

4. MEASUREMENT

This Item will be measured by the foot.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb," "Concrete Curb (Mono)," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of curb foundation, equipment, labor, materials, tools, and incidentals.

Item 531

Sidewalks



1. DESCRIPTION

Construct hydraulic cement concrete sidewalks.

2. MATERIALS

Furnish materials conforming to the following:

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete unless otherwise shown on the plans. Use Grade 8 course aggregate for extruded Class A concrete. Use other grades if approved.

3. CONSTRUCTION

Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Hand-tamp and sprinkle foundation when placement is directly on subgrade or foundation materials. Remove and dispose of existing concrete in accordance with Item 104, "Removing Concrete." Provide a clean surface for concrete placement directly on the surface material or pavement.

Mix and place concrete in accordance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Install joints as shown on the plans. Ensure that abrupt changes in sidewalk elevation do not exceed 1/4 in., sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope. Ensure that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans where a sidewalk crosses a concrete driveway.

Provide finished work with a well-compacted mass, a surface free from voids and honeycomb, and the required true-to-line shape and grade. Cure for at least 72 hr. in accordance with Item 420, "Concrete Substructures."

3.1. Conventionally Formed Concrete. Provide pre-molded or board expansion joints of the thickness shown on the plans for sidewalk section lengths greater than 8 ft. but less than 40 ft., unless otherwise directed. Terminate workday production at an expansion joint.

3.2. Extruded or Slipformed Concrete. Provide any additional surface finishing immediately after extrusion or slipforming as required on the plans. Construct joints at locations as shown on the plans or as directed.

4. MEASUREMENT

Sidewalks will be measured by the square yard of surface area. Curb ramps will be measured by the square yard of surface area or by each. A curb ramp consists of the ramp, landing, adjacent flares or side curb, and detectable warning surface as shown on the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Sidewalks" of the depth specified and "Curb Ramps" of the type specified. This price is full compensation for surface preparation of sidewalk foundation; materials; removal and disposal of existing concrete; excavation, hauling and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and connect to concrete driveways or turnouts will be measured and paid for in accordance with Item 530, "Intersections, Driveways, and Turnouts."

Item 644

Small Roadside Sign Assemblies



1.	DESCRIPTION ■ Installation. Furnish, fabricate, and erect small roadside sign assemblies or bridge mounted clearance sign assemblies consisting of the signs, sign supports, foundations (when required), and associated mounting hardware. ■ Relocation. Relocate existing small roadside sign assemblies or bridge mounted clearance sign assemblies, and furnish and fabricate material as required. ■ Removal. Remove existing small roadside sign assemblies or bridge mounted clearance sign assemblies.
2.	MATERIALS Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials that comply with the following Items and details shown on the plans: ■ Item 421, "Hydraulic Cement Concrete" ■ Item 440, "Reinforcement for Concrete" ■ Item 441, "Steel Structures" ■ Item 442, "Metal for Structures" ■ Item 445, "Galvanizing" ■ Item 636, "Signs" ■ Item 643, "Sign Identification Decals" ■ Item 656, "Foundations for Traffic Control Devices" Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for pipe, bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. When dissimilar metals are used, select or insulate metals to prevent corrosion.
3.	CONSTRUCTION Construct foundations in accordance with Item 656, "Foundations for Traffic Control Devices." Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult the appropriate utility company before beginning work. 3.1. Fabrication. Fabricate sign supports in accordance with Item 441, "Steel Structures." Ensure all components fit properly. Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans. Hot-dip galvanize fabricated parts in accordance with Item 445, "Galvanizing." Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged during assembly, transit, erection; or for any steel part or member welded, when permitted, after galvanizing. Perform all galvanizing repairs in accordance with Section 445.3.5., "Repairs."

- 3.2. Installation. Locate and install sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake sign support locations for verification by the Engineer.
- Install stub posts of the type, spacing, orientation, and projection shown on the plans. Remove and replace posts damaged during installation at the Contractor's expense.
- Connect the upper post sections to the stub post sections as shown on the plans. Torque connection bolts as shown on the plans.
- Attach signs to supports in accordance with the plans and pertinent Items.
- 3.3. Relocation. Reuse the existing signs as required unless otherwise shown on the plans. Furnish and install new stub posts in new foundations for relocated sign assemblies. Erect the new supports on the new stub posts, and attach the existing signs to the supports in accordance with the plans and pertinent Items. Remove existing foundations to be abandoned in accordance with Section 644.3.4., "Removal."
- 3.4. Removal. Remove abandoned concrete foundations to 2 ft. below finish grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.
- 3.5. Handling and Storage. Handle and store existing signs or portions of signs removed so they are not damaged. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.
- Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials, and dispose of them in accordance with federal, state, and local regulations.
- 3.6. Cleaning. Wash the entire sign after installation with a biodegradable cleaning solution acceptable to the sign face materials manufacturer to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

4. MEASUREMENT

This Item will be measured as each small roadside assembly or bridge mounted clearance sign assembly installed, removed, or relocated.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Small Roadside Sign Assemblies" of the type specified, "Install Bridge Mounted Clearance Sign Assemblies" of the type specified, "Relocate Small Roadside Sign Assemblies" of the type specified, "Relocate Bridge Mounted Clearance Sign Assemblies" of the type specified, "Remove Small Roadside Sign Assemblies," or "Remove Bridge Mounted Clearance Sign Assemblies."

- 5.1. Installation. This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports; constructing foundations including concrete (when required); furnishing complete signs including sign connections and all hardware; attaching the signs to the supports; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.
- 5.2. Relocation. This price is full compensation for removing existing sign assemblies and related materials; furnishing and installing new stub posts and new sign supports; constructing foundations including concrete (when required); and new hardware; reinstallation of signs; preparing and cleaning the signs; salvaging;

disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

- 5.3. Removal. This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

Item 100

Preparing Right of Way



1. DESCRIPTION

Prepare the right of way and designated easements for construction operations by removing and disposing of all obstructions when removal of such obstructions is not specifically shown on the plans to be paid by other Items.

2. CONSTRUCTION

Protect designated features on the right of way and prune trees and shrubs as directed. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation. Treat cuts on trees with an approved tree wound dressing within 20 min. of making a pruning cut or otherwise causing damage to the tree when shown on the plans. Follow all local and state regulations when burning. Pile and burn brush at approved locations as directed. Coordinate work with state and federal authorities when working in state or national forests or parks. Test, remove, and dispose of hazardous materials in accordance with Article 6.10., "Hazardous Materials."

Clear areas shown on the plans of all obstructions, except those landscape features that are to be preserved. Such obstructions include remains of houses and other structures, foundations, floor slabs, concrete, brick, lumber, plaster, septic tank drain fields, basements, abandoned utility pipes or conduits, equipment, fences, retaining walls, and other items as specified on the plans. Remove vegetation and other landscape features not designated for preservation, curb and gutter, driveways, paved parking areas, miscellaneous stone, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, and debris, whether above or below ground. Removal of live utility facilities is not included in this Item. Remove culverts, storm sewers, manholes, and inlets in proper sequence to maintain traffic and drainage.

Notify the Engineer in writing when items not shown on the plans and not reasonably detectable (buried with no obvious indication of presence) are encountered and required to be removed. These items will be handled in accordance with Article 4.5., "Differing Site Conditions."

Remove obstructions not designated for preservation to 2 ft. below natural ground in areas receiving embankment. Remove obstructions to 2 ft. below the excavation level in areas to be excavated. Remove obstructions to 1 ft. below natural ground in all other areas. Cut trees and stumps off to ground level when allowed by the plans or directed. Plug the remaining ends of abandoned underground structures over 3 in. in diameter with concrete to form a tight closure. Backfill, compact, and restore areas where obstructions have been removed unless otherwise directed. Use approved material for backfilling. Dispose of wells in accordance with Item 103, "Disposal of Wells."

Accept ownership, unless otherwise directed, and dispose of removed materials and debris at locations off the right of way in accordance with local, state, and federal requirements.

3. MEASUREMENT

This Item will be measured by the acre; by the 100-ft. station, regardless of the width of the right of way; or by each tree removed.

4. PAYMENT

For "acre" and "station" measurement, the work performed in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not paid for separately for "Preparing Right of Way." For "each" measurement, the work performed in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not paid for separately for "Preparing Right of Way (Tree)" of the diameter specified. This price is full compensation for pruning of designated trees and shrubs; removal and disposal of structures and obstructions; backfilling of holes; furnishing and placing concrete for plugs; and equipment, labor, tools, and incidentals.

Item 104

Removing Concrete



1. DESCRIPTION

Break, remove, and salvage or dispose of existing hydraulic cement concrete.

2. CONSTRUCTION

Remove existing hydraulic cement concrete from locations shown on the plans. Avoid damaging concrete that will remain in place. Saw-cut and remove the existing concrete to neat lines. Replace any concrete damaged by the Contractor at no expense to the Department. Accept ownership and properly dispose of broken concrete in accordance with federal, state, and local regulations unless otherwise shown on the plans.

3. MEASUREMENT

Removing concrete pavement, floors, porches, patios, riprap, medians, foundations, sidewalks, driveways, and other appurtenances will be measured by the square yard (regardless of thickness) or by the cubic yard of calculated volume, in its original position.

Removing curb, curb and gutter, and concrete traffic barrier will be measured by the foot in its original position. The removal of monolithic concrete curb or dowelled concrete curb will be included in the concrete pavement measurement.

Removing retaining walls will be measured by the square yard along the front face from the top of the wall to the top of the footing.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

4. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" and payment will be included in the contract costs and not paid for separately for "Removing Concrete" of the type specified. This price is full compensation for breaking the concrete; loading, hauling, and salvaging or disposing of the material; and equipment, labor, tools, and incidentals.

Removing retaining wall footings will not be paid for directly but will be considered subsidiary to this item.

Item 105

Removing Treated and Untreated Base and Asphalt Pavement



1.	DESCRIPTION Break, remove, and store or dispose of existing asphalt pavement, including surface treatments, and treated or untreated base materials.
2.	CONSTRUCTION Break material retained by the Department into pieces not larger than 24 in. unless otherwise shown on the plans. Remove existing asphalt pavement before disturbing stabilized base. Avoid contamination of the asphalt materials and damage to adjacent areas. Repair material damaged by operations outside the designated locations. Stockpile materials designated salvageable at designated sites when shown on the plans or as directed. Prepare stockpile site by removing vegetation and trash and by providing for proper drainage. Material not designated to be salvaged will become the property of the Contractor. When this material is disposed of, do so in accordance with federal, state, and local regulations.
3.	MEASUREMENT This Item will be measured by the 100-ft. station along the baseline of each roadbed, by the square yard of existing treated or untreated base and asphalt pavement in its original position, or by the cubic yard of existing treated or untreated base and asphalt pavement in its original position, as calculated by the average end area method. Square yard and cubic yard measurement will be established by the widths and depths shown on the plans and the lengths measured in the field.
4.	PAYMENT The work performed in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Removing Treated and Untreated Base and Asphalt Pavement" of the depth specified. This price is full compensation for breaking the material, loading, hauling, unloading, stockpiling or disposing; repair to areas outside designated locations for removal; and equipment, labor, tools, and incidentals.

Item 110

Excavation



1.	DESCRIPTION Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.
2.	CONSTRUCTION Accept ownership of unsuitable or excess material and dispose of material in accordance with local, state, and federal regulations at locations outside the right of way. Maintain drainage in the excavated area to avoid damage to the roadway section. Correct any damage to the subgrade caused by weather at no additional cost to the Department. Shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides as directed. 2.1. Rock Cuts. Excavate to finish subgrade. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods," unless excavation is to clean homogenous rock at finish subgrade elevation. Use approved embankment material compacted in accordance with Section 132.3.4., "Compaction Methods," to replace undercut material at no additional cost if excavation extends below finish subgrade. 2.2. Earth Cuts. Excavate to finish subgrade. Scarify subgrade to a uniform depth at least 6 in. below finish subgrade elevation in areas where base or pavement structure will be placed on subgrade. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods." Take corrective measures as directed if unsuitable material is encountered below subgrade elevations. 2.3. Subgrade Tolerances. Excavate to within 1/2 in. in cross-section and 1/2 in. in 16 ft. measured longitudinally for turnkey construction. Excavate to within 0.1 ft. in cross-section and 0.1 ft. in 16 ft. measured longitudinally for staged construction.
3.	MEASUREMENT This Item will be measured by the cubic yard in its original position as computed by the method of average end areas. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required. Limits of measurement for excavation in retaining wall areas will be as shown on the plans. Shrinkage or swelling factors will not be considered in determining the calculated quantities.

4. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Excavation (Roadway)," "Excavation (Channel)," "Excavation (Special)," or "Excavation (Roadway and Channel)." This price is full compensation for authorized excavation; drying; undercutting subgrade and reworking or replacing the undercut material in rock cuts; hauling; disposal of material not used elsewhere on the project; scarification and compaction; and equipment, labor, materials, tools, and incidentals.

Drying required deeper than 6 in. below subgrade elevation will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation and replacement of unsuitable material below subgrade elevations will be performed in accordance with the applicable bid items and paid for in accordance with Article 9.7, "Payment for Extra Work and Force Account Method." However, if Item 132, "Embankment," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When a slide not due to the Contractor's negligence or operation occurs, payments for removal and disposal of the slide material will be in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation in backfill areas of retaining walls will not be measured or paid for directly but will be subsidiary to pertinent Items.

Item 216

Proof Rolling



1.	DESCRIPTION Proof-roll earthwork, base, or both to locate unstable areas.
2.	EQUIPMENT 2.1. Specified Equipment. Furnish rollers that weigh at least 25 tons when loaded. The maximum acceptable load is 50 tons. Provide rollers that meet the requirements of Section 210.2.4., "Pneumatic Tire Rollers." 2.2. Alternative Equipment. The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment in the same period of time as approved. Discontinue the use of the alternative equipment and furnish the specified equipment if the desired results are not achieved.
3.	CONSTRUCTION Perform proof rolling as directed. Adjust the load and tire inflation pressures within the range of the manufacturer's charts or tabulations, as directed. Make at least 2 coverages with the proof roller. Offset each trip of the roller by at most one tire width. Operate rollers at a speed between 2 and 6 mph, as directed. Correct unstable or nonuniform areas, if found, in accordance with the applicable Item.
4.	MEASUREMENT Rolling will be measured by the hour operated on surfaces being tested.
5.	PAYMENT The work performed and equipment furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Proof Rolling." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

Item 260

Lime Treatment (Road-Mixed)



1.	DESCRIPTION Mix and compact lime, water, and subgrade or base (with or without asphaltic concrete pavement) in the roadway.
2.	MATERIALS Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. Obtain verification from the Engineer that the specification requirements are met before using the sources. The Engineer may sample and test project materials at any time before compaction. Use Tex-100-E for material definitions. 2.1. Lime. Furnish lime that meets the requirements of DMS-6350, "Lime and Lime Slurry," and DMS-6330, "Pre-Qualification of Lime Sources." Use hydrated lime, commercial lime slurry, quicklime, or carbide lime slurry as shown on the plans. Do not use quicklime when sulfates are present in quantities greater than 3,000 ppm. When furnishing quicklime, provide it in bulk. 2.2. Subgrade. The Engineer will determine the sulfate content of the existing subgrade in accordance with Tex-145-E and organic content in accordance with Tex-148-E before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 1.0% and proceed as directed. 2.3. Flexible Base. Unless otherwise shown on the plans, furnish base material that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans, before the addition of lime. 2.4. Water. Furnish water free of industrial wastes and other objectionable material. 2.5. Asphalt. When asphalt or emulsion is permitted for curing purposes, furnish materials that meet the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or as directed. 2.6. Mix Design. The Engineer will determine the target lime content and optimum moisture content in accordance with Tex-121-E or prior experience with the project materials. The Contractor may propose a mix design developed in accordance with Tex-121-E. The Engineer will use Tex-121-E to verify the Contractor's proposed mix design before acceptance. Reimburse the Department for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor. Limit the amount of recycled asphalt pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.
3.	EQUIPMENT Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required. 3.1. Storage Facility. Store quicklime and dry hydrated lime in closed, weatherproof containers.

- 3.2. Slurry Equipment. Use slurry tanks equipped with agitation devices to slurry hydrated lime or quicklime on the project or other approved location. The Engineer may approve other slurring methods.
- 3.3. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with [Tex-600-J](#), Part I, when using commercial lime slurry or carbide lime slurry.
- 3.4. Hydrated Lime Distribution Equipment. Provide equipment to spread lime evenly across the area to be treated. Provide equipment with a rotary vane feeder to spread lime, when shown on the plans.
- 3.5. Pulverization Equipment. Provide pulverization equipment that:
- cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut,
 - provides a visible indication of the depth of cut at all times, and
 - uniformly mixes the materials.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

- 4.1. Preparation of Subgrade or Existing Base for Treatment. Before treating, remove existing asphalt pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape existing material in accordance with applicable bid items to conform to typical sections shown on the plans and as directed.

Unless otherwise approved, proof roll the roadbed in accordance with Item 216, "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

When material is imported from a borrow source, notify the Engineer of the location of the borrow source well in advance to allow time for testing and approval to avoid delay to the project. Stockpile as directed. The Engineer will test the borrow source and determine the sulfate and organic contents. When the borrow source has a sulfate content greater than 3,000 ppm or an organic content greater than 1.0%, proceed as directed.

When new base material is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix new base with existing material to provide a uniform mixture to the specified depth before shaping.

- 4.2. Pulverization. Pulverize or scarify existing material after shaping so that 100% passes a 2-1/2 in. sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

- 4.3. Application of Lime. Uniformly apply lime using dry or slurry placement as shown on the plans or as directed. Add lime at the percentage determined in Section 260.2.6., "Mix Design." Apply lime only on an area where mixing can be completed during the same working day.

Start lime application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of lime by wind. Do not apply lime when wind conditions, in the opinion of the Engineer, cause blowing lime to become dangerous to traffic or objectionable to adjacent property owners.

When pebble grade quicklime is placed dry, mix the material and lime thoroughly at the time of lime application. Use of quicklime can be dangerous. Inform users of the recommended precautions for handling and storage.

- 4.3.1. Dry Placement. Before applying lime, bring the prepared roadway to approximately 2 percentage points above optimum moisture content. When necessary, sprinkle in accordance with Item 204, "Sprinkling." Distribute the required quantity of hydrated lime or pebble grade quicklime with approved equipment. Only hydrated lime may be distributed by bag. Do not use a motor grader to spread hydrated lime.
- 4.3.2. Slurry Placement. Provide slurry free of objectionable materials, at or above the minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry or carbide lime slurry to the jobsite, or use hydrated lime or quicklime to prepare lime slurry at the jobsite or other approved location, as specified. When dry quicklime is applied as slurry, use 80% of the amount shown on the plans.

Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached. Uniformly spread the residue from quicklime slurry over the length of the roadway being processed, unless otherwise directed.

- 4.4. Mixing. Begin mixing within 6 hr. of application of lime. Hydrated lime exposed to the open air for 6 hr. or more between application and mixing, or that experiences excessive loss due to washing or blowing, will not be accepted for payment.

Thoroughly mix the material and lime using approved equipment. When treating subgrade, bring the moisture content above the optimum moisture content to insure adequate chemical reaction of the lime and subgrade materials. Allow the mixture to mellow for 1 to 4 days, as directed. When pebble grade quicklime is used, allow the mixture to mellow for 2 to 4 days, as directed. Sprinkle the treated materials during the mixing and mellowing operation, as directed, to achieve adequate hydration and proper moisture content. When the material to be treated has a sulfate content greater than 3,000 ppm but less than or equal to 7,000 ppm, mellow for a minimum of 7 days. Maintain in a continuously moist condition by sprinkling in accordance with Item 204, "Sprinkling." After mellowing, resume mixing until a homogeneous, friable mixture is obtained. After mixing, the Engineer may sample the mixture at roadway moisture and test in accordance with [Tex-101-E](#), Part III, to determine compliance with the gradation requirements in Table 1.

Table 1
Gradation Requirements (Minimum % Passing)

Sieve Size	Base	Subgrade
1-3/4"	100	100
3/4"	85	85
#4	—	60

- 4.5. Compaction. Compact the mixture using density control, unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. Sprinkle the treated material in accordance with Item 204, "Sprinkling" or aerate the treated material to adjust the moisture content during compaction so that it is no more than 1.0 percentage points below optimum and 2.0 percentage points above optimum as determined by [Tex-121-E](#). Measure the moisture content of the material in accordance with [Tex-115-E](#) or [Tex-103-E](#) during compaction daily and report the results the same day, unless otherwise shown on the plans or directed.

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Before final acceptance, the Engineer will select the locations of tests in each unit and measure the treated depth in accordance with [Tex-140-E](#). Correct areas deficient by more than 1/2 in. in thickness or more than

1/2% in target lime content by adding lime as required, reshaping, recompacting, and refinishing at the Contractor's expense.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Rework in accordance with Section 260.4.6., "Reworking a Section." Perform the work at no additional expense to the Department.

- 4.5.1. Ordinary Compaction. Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.
- 4.5.2. Density Control. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#). The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.
 - 4.5.2.1. Subgrade. Compact to at least 95% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans.
 - 4.5.2.2. Base. Compact the bottom course to at least 95% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans. Compact subsequent courses treated under this Item to at least 98% of the maximum density determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans.
- 4.6. Reworking a Section. When a section is reworked within 72 hr. after completion of compaction, rework the section to provide the required density. When a section is reworked more than 72 hr. after completion of compaction, add additional lime at 25% of the percentage determined in Section 260.2.6., "Mix Design." Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing as directed, compacting, and finishing. When density control is specified, determine a new maximum density of the reworked material in accordance with [Tex-121-E](#), and compact to at least 95% of this density.
- 4.7. Finishing. Immediately after completing compaction of the final course, clip, skin, or tight-blade the surface of the lime-treated material with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of at an approved location. Roll the clipped surface immediately with a pneumatic tire roller until a smooth surface is attained. Add small amounts of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades shown on the plans or as directed.

Finish grade of constructed subgrade to within 0.1 ft. in the cross-section and 0.1 ft. in 16 ft. measured longitudinally.

Correct grade deviations of constructed base greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape, and roll with a pneumatic-tire roller. Correct as directed if material is more than 1/4 in. low. Do not surface patch. The 72-hr. time limit required for completion of placement, compaction, and finishing does not apply to finishing required just before applying the surface course.
- 4.8. Curing. Cure for the minimum number of days shown in Table 2 by sprinkling in accordance with Item 204, "Sprinkling," or by applying an asphalt material at a rate of 0.05 to 0.20 gal. per square yard as directed. Maintain moisture during curing. Upon completion of curing, maintain the moisture content in accordance with Section 132.3.5., "Maintenance of Moisture and Reworking," for subgrade and Section 247.4.5., "Curing" for bases before placing subsequent courses. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Apply seals or additional courses within 14 calendar days of final compaction.

Table 2
Minimum Curing Requirements before Placing Subsequent Courses¹

Untreated Material	Curing (Days)
PI ≤ 35	2
PI > 35	5

1. Subject to the approval of the Engineer. Proof rolling may be required as an indicator of adequate curing.

5. MEASUREMENT

- 5.1. Lime. When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."
- When lime is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.
- 5.1.1. Hydrated Lime.
- 5.1.1.1. Dry. Lime will be measured by the ton (dry weight).
- 5.1.1.2. Slurry. Lime slurry will be measured by the ton (dry weight) of the hydrated lime used to prepare the slurry at the jobsite.
- 5.1.2. Commercial Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 5.1.3. Quicklime.
- 5.1.3.1. Dry. Lime will be measured by the ton (dry weight) of the quicklime.
- 5.1.3.2. Slurry. Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.
- 5.1.4. Carbide Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 5.2. Lime Treatment. Lime treatment will be measured by the square yard of surface area. The dimensions for determining the surface area are established by the widths shown on the plans and the lengths measured at placement.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not paid for separately.

Furnishing and delivering new base will be paid for in accordance with Article 4.4, "Changes in the Work". . " Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for in accordance with Article 4.4, "Changes in the Work" Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with Article 4.4., "Changes in the Work."

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with Article 4.4, "Changes in the Work"

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Where subgrade to be treated under this Contract has sulfates greater than 7,000 ppm, work will be paid for in accordance with Article 4.4., "Changes in the Work."

Asphalt used solely for curing will not be paid for directly but will be subsidiary to this Item. Asphalt placed for curing and priming will be paid for under Article 4.4, "Changes in the Work"

6.1. Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following types:

- Hydrated Lime (Dry),
- Hydrated Lime (Slurry),
- Commercial Lime Slurry,
- Quicklime (Dry),
- Quicklime (Slurry), or
- Carbide Lime Slurry.

This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

Lime used for reworking a section in accordance with Section 260.4.6., "Reworking a Section," will not be paid for directly but will be subsidiary to this Item.

6.2. Lime Treatment. Lime treatment will be included in the contract costs and not paid for separately. for "Lime Treatment (Existing Material)," "Lime Treatment (New Base)," or "Lime Treatment (Mixing Existing Material and New Base)," for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying lime, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

Item 360

Concrete Pavement



1. DESCRIPTION

Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.

2. MATERIALS

- 2.1. **Hydraulic Cement Concrete.** Provide hydraulic cement concrete in accordance with Item 421, "Hydraulic Cement Concrete." Use compressive strength testing unless otherwise shown on the plans. Provide Class P concrete designed to meet a minimum average compressive strength of 3,200 psi or a minimum average flexural strength of 450 psi at 7 days or a minimum average compressive strength of 4,000 psi or a minimum average flexural strength of 570 psi at 28 days. Test in accordance with [Tex-448-A](#) or [Tex-418-A](#).

Obtain written approval if the concrete mix design exceeds 520 lb. per cubic yard of cementitious material.

Use coarse aggregates for continuously reinforced concrete pavements to produce concrete with a coefficient of thermal expansion not more than 5.5×10^{-6} in./in./°F. Provide satisfactory [Tex-428-A](#) test data from an approved testing laboratory if the coarse aggregate coefficient of thermal expansion listed on the Department's *Concrete Rated Source Quality Catalog* is not equal to or less than 5.5×10^{-6} in./in./°F.

Provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic when shown on the plans or allowed. Design Class HES to meet the requirements of Class P and a minimum average compressive strength of 3,200 psi or a minimum average flexural strength of 450 psi in 24 hr., unless other early strength and time requirements are shown on the plans or allowed.

Use Class A or P concrete meeting the requirements of Item 421, "Hydraulic Cement Concrete," and this Item for curbs that are placed separately from the pavement.

- 2.2. **Reinforcing Steel.** Provide Grade 60 or above, deformed steel for bar reinforcement in accordance with Item 440, "Reinforcement for Concrete." Provide positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving. Provide corrosion protection when shown on the plans.
- 2.2.1. **Dowels.** Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 440, "Reinforcement for Concrete." Coat dowels with a thin film of grease, wax, silicone or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.
- 2.2.2. **Tie Bars.** Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Furnish multiple piece tie bar assemblies from the list of approved multiple-piece tie bars that have been prequalified in accordance with DMS-4515, "Multiple Piece Tie Bars for Concrete Pavements," when used. Multiple-piece tie bars used on individual projects must be sampled in accordance with [Tex-711-I](#), and tested in accordance with DMS-4515 "Multiple Piece Tie Bars for Concrete Pavements."
- 2.3. **Alternative Reinforcing Materials.** Provide reinforcement materials of the dimensions and with the physical properties specified when allowed or required by the plans. Provide manufacturer's certification of required material properties.

- 2.4. **Curing Materials.** Provide Type 2 membrane curing compound conforming to [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS-1 emulsified asphalt conforming to Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 422, "Concrete Superstructures." Provide insulating blankets for curing fast track concrete pavement with a minimum thermal resistance (R) rating of 0.5 hour-square foot F/BTU. Use insulating blankets that are free from tears and are in good condition.
- 2.5. **Epoxy.** Provide Type III, Class C epoxy in accordance with [DMS-6100](#), "Epoxies and Adhesives," for installing all drilled-in reinforcing steel. Submit a work plan and request approval for the use of epoxy types other than Type III, Class C.
- 2.6. **Evaporation Retardant.** Provide evaporation retardant conforming to [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."
- 2.7. **Joint Sealants and Fillers.** Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with [DMS-6310](#), "Joint Sealants and Fillers."

3. EQUIPMENT

Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 421, "Hydraulic Cement Concrete." Obtain approval for other equipment used.

- 3.1. **Placing, Consolidating, and Finishing Equipment.** Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically-operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist.

When string-less paving equipment is used, use Section 5.9.3, "Method C," and establish control points at maximum intervals of 500 ft. Use these control points as reference to perform the work.

Provide mechanically-operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations. Provide immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at all joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators.

For small or irregular areas or when approved, the paving equipment described in this Section is not required.

- 3.2. **Forming Equipment.**

- 3.2.1. **Pavement Forms.** Provide metal side forms of sufficient cross-section, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100-ft. radius or less.

- 3.2.2. **Curb Forms.** Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter."
- 3.3. **Reinforcing Steel Inserting Equipment.** Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details when approved.
- 3.4. **Texturing Equipment.**
- 3.4.1. **Carpet Drag.** Provide a carpet drag mounted on a work bridge or a manual moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications.
- 3.4.2. **Tining Equipment.** Provide a self-propelled metal tine device equipped with steel tines with cross-section approximately 1/32 in. thick × 1/12 in. wide. Provide tines for transverse tining equipment spaced at approximately 1 in., center-to-center, or provide tines for longitudinal tining equipment spaced at approximately 3/4 in., center-to-center. Manual methods that produce an equivalent texture may be used when it is impractical to use self-propelled equipment, such as for small areas, narrow width sections, and in emergencies due to equipment breakdown.
- 3.5. **Curing Equipment.** Provide a self-propelled machine for applying membrane curing compound using mechanically-pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when required to meet the requirements of Section 360.4.9., "Curing." Hand-operated pressurized spraying equipment with atomizing nozzles may only be used on small or irregular areas, narrow width sections, or in emergencies due to equipment breakdown.
- 3.6. **Sawing Equipment.** Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations.
- 3.7. **Grinding Equipment.** Provide self-propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades when required. Provide equipment with automatic grade control capable of grinding at least a 3-ft. width longitudinally in each pass without damaging the concrete.
- 3.8. **Testing Equipment.** Provide testing equipment regardless of job-control testing responsibilities in accordance with Item 421, "Hydraulic Cement Concrete," unless otherwise shown on the plans or specified.
- 3.9. **Coring Equipment.** Provide coring equipment capable of extracting cores in accordance with the requirements of [Tex-424-A](#) when required.
- 3.10. **Miscellaneous Equipment.** Furnish both 10-ft. and 15-ft. steel or magnesium long-handled, standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations.

4. CONSTRUCTION

Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water before placing pavement concrete.

Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.

- 4.1. **Paving and Quality Control Plan.** Submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including methods to construct transverse joints, methods to consolidate concrete at joints, longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.

- 4.2. **Job-Control Testing.** Perform all fresh and hardened concrete job-control testing at the specified frequency unless otherwise shown on the plans. Provide job-control testing personnel meeting the requirements of Item 421, "Hydraulic Cement Concrete." Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump and temperature to verify concrete conformance and consistency on start-up production days. Sample and prepare strength-test specimens (2 specimens per test) on the first day of production and for each 3,000 sq. yd. or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump and temperature tests each time strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

The Engineer will perform job-control testing when the testing by the Contractor is waived by the plans; however, this does not waive the Contractor's responsibility for providing materials and work in accordance with this Item.

- 4.2.1. **Job-Control Strength.** Use 7-day job-control concrete strength testing in accordance with [Tex-448-A](#) or [Tex-418-A](#) unless otherwise shown on the plans or permitted.

Use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,000 psi as correlated in accordance with [Tex-427-A](#) for 7-day job-control by compressive strength. Use a flexural strength of 450 psi or a lower job-control strength value proven to meet a 28-day flexural strength of 570 psi as correlated in accordance with [Tex-427-A](#) for 7-day job-control by flexural strength.

Job control of concrete strength may be correlated to an age other than 7 days in accordance with [Tex-427-A](#) when approved. Job-control strength of Class HES concrete is based on the required strength and time.

Investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause when a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive job-control strength values fall below the required job-control strength. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low-strength test values in a timely manner. The Engineer will evaluate the structural adequacy of the pavements if any job-control strength is more than 15% below the required job-control strength. Remove and replace pavements found to be structurally inadequate at no additional cost when directed.

- 4.2.2. **Split-Sample Verification Testing.** Perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 job-control samples. The Engineer

will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or the average of 10 job-control strength results and the Engineer's split-sample strength result differ by more than 10%.

Table 1
Verification Testing Limits

Test Method	Allowable Differences
Temperature, Tex-422-A	2°F
Flexural strength, Tex-448-A	19%
Compressive strength, Tex-418-A	10%

- 4.3. **Reinforcing Steel and Joint Assemblies.** Accurately place and secure in position all reinforcing steel as shown on the plans. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the lap locations so that no more than 1/3 of the longitudinal steel is spliced in any given 12-ft. width and 2-ft. length of the pavement. Use multiple-piece tie bars, drill and epoxy grout tie bars, or, if approved, mechanically-inserted single-piece tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied or mechanically inserted into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of 3/4 of the yield strength of the steel after 7 days. Test 15 bars using ASTM E488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. Perform corrective measures to provide equivalent pullout resistance if any of the test results do not meet the required minimum pullout strength. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.
- 4.3.1. **Manual Placement.** Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.
- 4.3.2. **Mechanical Placement.** Complete the work using manual placement methods described above if mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies.
- 4.4. **Joints.** Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with Item 438, "Cleaning and Sealing Joints." Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. Install a rigid transverse bulkhead, for the reinforcing steel, and shaped accurately to the cross-section of the pavement when placing of concrete is stopped.
- 4.4.1. **Placing Reinforcement at Joints.** Complete and place the assembly of parts at pavement joints at the required location and elevation, with all parts rigidly secured in the required position, when shown on the plans.
- 4.4.2. **Transverse Construction Joints.**
- 4.4.2.1. **Continuously Reinforced Concrete Pavement (CRCP).** Install additional longitudinal reinforcement through the bulkhead when shown on the plans. Protect the reinforcing steel immediately beyond the construction joint from damage, vibration, and impact.
- 4.4.2.2. **Concrete Pavement Contraction Design (CPCD).** Install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location when the placing of concrete is intentionally stopped. Install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints when the placing of concrete is unintentionally stopped. Install tie bars of the size and spacing used in the longitudinal joints for mid-slab construction joints.

- 4.4.2.3. **Curb Joints.** Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. Place reinforcing steel into the plastic concrete pavement for non-monolithic curbs as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter."
- 4.5. **Placing and Removing Forms.** Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement.
- Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met. Stop paving operations if forms settle or deflect more than 1/8 in. under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade.
- Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hr. after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hr. after a bulkhead for a transverse construction joint has been removed unless otherwise approved. Promptly apply membrane curing compound to the edge of the concrete pavement when forms are removed before 72 hr. after concrete placement.
- Forms that are not the same depth as the pavement, but are within 2 in. of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100-ft. radius or less.
- 4.6. **Concrete Delivery.** Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 in. Segregated concrete is subject to rejection.
- Begin the discharge of concrete delivered in agitated delivery equipment conforming to the requirements of Item 421, "Hydraulic Cement Concrete." Place non-agitated concrete within 45 min. after batching. Reduce times as directed when hot weather or other conditions cause quick setting of the concrete.
- 4.7. **Concrete Placement.** Do not allow the pavement edge to deviate from the established paving line by more than 1/2 in. at any point. Place the concrete as near as possible to its final location, and minimize segregation and rehandling. Distribute concrete using shovels where hand spreading is necessary. Do not use rakes or vibrators to distribute concrete.
- 4.7.1. **Consolidation.** Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete along forms, at all joints and in areas not accessible to the machine-mounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.
- 4.7.2. **Curbs.** Conform to the requirements of Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter" where curbs are placed separately.

- 4.7.3. **Temperature Restrictions.** Place concrete that is between 40°F and 95°F when measured in accordance with [Tex-422-A](#) at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.

Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or above 40°F. Protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period when temperatures warrant protection against freezing. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72 hr. after placement. Repair or replace all concrete damaged by freezing.

- 4.8. **Spreading and Finishing.** Finish all concrete pavement with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike-off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.

- 4.8.1. **Finished Surface.** Perform sufficient checks with long-handled 10-ft. and 15-ft. straightedges on the plastic concrete to ensure the final surface is within the tolerances specified in Surface Test A in Item 585, "Ride Quality for Pavement Surfaces." Check with the straightedge parallel to the centerline.

- 4.8.2. **Maintenance of Surface Moisture.** Prevent surface drying of the pavement before application of the curing system by means that may include water fogging, the use of wind screens, and the use of evaporation retardants. Apply evaporation retardant at the manufacturer's recommended rate. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shutdown of pavement operations.

- 4.8.3. **Surface Texturing.** Complete final texturing before the concrete has attained its initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet dragging operations while there is excessive bleed water.

A metal-tine texture finish is required unless otherwise shown on the plans. Provide transverse tining unless otherwise shown on the plans. Immediately following the carpet drag, apply a single coat of evaporation retardant, if needed, at the rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves approximately 3/16 in. deep, with a minimum depth of 1/8 in., and approximately 1/12 in. wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps, small or irregular areas, and narrow width sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

Target a carpet drag texture of 0.04 in., as measured by [Tex-436-A](#), when carpet drag is the only surface texture required on the plans. Ensure adequate and consistent macro-texture is achieved by applying enough weight to the carpet and by keeping the carpet from getting plugged with grout. Correct any location with a texture less than 0.03 in. by diamond grinding or shot blasting. The Engineer will determine the test locations at points located transversely to the direction of traffic in the outside wheel path.

- 4.8.4. **Small, Irregular Area, or Narrow Width Placements.** Use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade where machine placements and finishing of concrete pavement are not practical.

- 4.8.5. **Emergency Procedures.** Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.
- 4.9. **Curing.** Keep the concrete pavement surface from drying as described in Section 360.4.8.2., "Maintenance of Surface Moisture," until the curing material has been applied. Maintain and promptly repair damage to curing materials on exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24-hr. period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hr. or the surface temperature of the concrete is maintained above 40°F for 24 hr. Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 422, "Concrete Superstructures," may be used when specified or approved.
- 4.9.1. **Membrane Curing.** Spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of no more than 180 sq. ft. per gallon. Apply the curing compound before allowing the concrete surface to dry.
- Manage finishing and texturing operations to ensure placement of curing compound on a moist concrete surface, relatively free of bleed water, to prevent any plastic shrinkage cracking. Time the application of curing compound to prevent plastic shrinkage cracking.
- Maintain curing compounds in a uniformly agitated condition, free of settlement before and during application. Do not thin or dilute the curing compound.
- Apply additional compound at the same rate of coverage to correct damage where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage. Ensure that the curing compound coats the sides of the tining grooves.
- 4.9.2. **Asphalt Curing.** Apply a uniform coating of asphalt curing at a rate of 90 to 180 sq. ft. per gallon when an asphaltic concrete overlay is required. Apply curing immediately after texturing and once the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.
- 4.9.3. **Curing Class HES Concrete.** Provide membrane curing in accordance with Section 360.4.9.1., "Membrane Curing," for all Class HES concrete pavement. Promptly follow by wet mat curing in accordance with Section 422.4.8., "Final Curing," until opening strength is achieved but not less than 24 hr.
- 4.9.4. **Curing Fast-Track Concrete Pavement.** Provide wet mat curing unless otherwise shown on the plans or as directed. Cure in accordance with Section 422.4.8., "Final Curing." Apply a Type 1-D or Type 2 membrane cure instead of wet mat curing if the air temperature is below 65°F and insulating blankets are used.
- 4.10. **Sawing Joints.** Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw-cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hr. of curing.
- 4.11. **Protection of Pavement and Opening to Traffic.** Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown on the plans or as directed. Testing result interpretation for opening to traffic is subject to approval.
- 4.11.1. **Protection of Pavement.** Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Protect the pavement from damage due to crossings using approved methods before opening to traffic. Where a detour

is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required.

Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

- 4.11.2. **Opening Pavement to All Traffic.** Pavement that is 7 days old may be opened to all traffic. Clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work before opening to traffic.
- 4.11.3. **Opening Pavement to Construction Equipment.** Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hr. old and opening strength has been demonstrated in accordance with Section 360.4.11.4., “Early Opening to All Traffic,” before curing is complete. Keep delivery equipment at least 2 ft. from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 ft. from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.
- 4.11.4. **Early Opening to All Traffic.** Concrete pavement may be opened after curing is complete and the concrete has attained a flexural strength of 450 psi or a compressive strength of 3,200 psi, except that pavement using Class HES concrete may be opened after 24 hr. if the specified strength is achieved.
- 4.11.4.1. **Strength Testing.** Test concrete specimens cured under the same conditions as the portion of the pavement involved.
- 4.11.4.2. **Maturity Method.** Use the maturity method, [Tex-426-A](#), to estimate concrete strength for early opening pavement to traffic unless otherwise shown on the plans. Install at least 2 maturity sensors for each day's placement in areas where the maturity method will be used for early opening. Maturity sensors, when used, will be installed near the day's final placement for areas being evaluated for early opening. Use test specimens to verify the strength–maturity relationship in accordance with [Tex-426-A](#), starting with the first day's placement corresponding to the early opening pavement section.

Verify the strength–maturity relationship at least every 10 days of production after the first day. Establish a new strength–maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength–maturity relationship deviates by more than 10% until a new strength–maturity relationship is established.

The Engineer will determine the frequency of verification when the maturity method is used intermittently or for only specific areas.
- 4.11.5. **Fast Track Concrete Pavement.** Open the pavement after the concrete has been cured for at least 8 hr. and attained a minimum compressive strength of 1,800 psi or a minimum flexural strength of 255 psi when tested in accordance with Section 360.4.11.4.1., “Strength Testing,” or Section 360.4.11.4.2., “Maturity Method,” unless otherwise directed. Cover the pavement with insulating blankets when the air temperature is below 65°F until the pavement is opened to traffic.
- 4.11.6. **Emergency Opening to Traffic.** Open the pavement to traffic under emergency conditions, when the pavement is at least 72 hr. old when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.

- 4.12. **Pavement Thickness.** The Engineer will check the thickness in accordance with [Tex-423-A](#) unless other methods are shown on the plans. The Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of the paving equipment every 500 ft. or fraction thereof. Core where directed, in accordance with [Tex-424-A](#), to verify deficiencies of more than 0.2 in. from plan thickness and to determine the limits of deficiencies of more than 0.75 in. from plan thickness. Fill core holes using an approved concrete mixture and method.
- 4.12.1. **Thickness Deficiencies Greater than 0.2 in.** Take one 4-in. diameter core at that location to verify the measurement when any depth test measured in accordance with [Tex-423-A](#) is deficient by more than 0.2 in. from the plan thickness.
- Take 2 additional cores from the unit (as defined in Section 360.4.12.3., "Pavement Units for Payment Adjustment" at intervals of at least 150 ft. and at selected locations if the core is deficient by more than 0.2 in., but not by more than 0.75 in. from the plan thickness, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 in. will be considered as the specified thickness plus 0.2 in.
- 4.12.2. **Thickness Deficiencies Greater than 0.75 in.** Take additional cores at 10-ft. intervals in each direction parallel to the centerline to determine the boundary of the deficient area if a core is deficient by more than 0.75 in. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 in., but not more than 1 in. Remove and replace the deficient areas without additional compensation or retain deficient areas without compensation, as directed. Remove and replace any area of pavement found deficient in thickness by more than 1 in. without additional compensation.
- 4.12.3. **Pavement Units for Payment Adjustment.** Limits for applying a payment adjustment for deficient pavement thickness from 0.20 in. to not more than 0.75 in. are 500 ft. of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards.
- For greater than 0.75 in. deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 in. deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10-ft. interval investigation as determined by the Engineer.
- Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 ft. wide or wider will be considered as lanes. Shoulders less than 6 ft. wide will be considered part of the adjacent lane.
- Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 ft. in length. Areas less than 500 ft. in length will be individually evaluated for payment adjustment based on the plan area.
- 4.13. **Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

This Item will be measured as follows:

- 5.1. **Concrete Pavement.** Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.
- 5.2. **Curb.** Curb on concrete pavement will be measured by the foot in place.

6. PAYMENT

These prices are full compensation for materials, equipment, labor, tools, and incidentals.

- 6.1. **Concrete Pavement.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for at the adjusted unit price bid for "Concrete Pavement" of the type and depth specified as adjusted in accordance with Section 360.6.2., "Deficient Thickness Adjustment."
- 6.2. **Deficient Thickness Adjustment.** Where the average thickness of pavement is deficient in thickness by more than 0.2 in. but not more than 0.75 in., payment will be made using the adjustment factor as specified in Table 2 applied to the bid price for the deficient area for each unit as defined under Section 360.4.12.3., "Pavement Units for Payment Adjustment."

Table 2
Deficient Thickness Price Adjustment Factor

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (Adjustment Factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

- 6.3. **Curb.** Work performed and furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Curb" of the type specified.

Item 402

Trench Excavation Protection



1.	DESCRIPTION Furnish and place excavation protection for trenches 5 ft. or greater in depth.
2.	CONSTRUCTION Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR Part 1926, Subpart P, "Excavations."
3.	MEASUREMENT This Item will be measured by the foot along the long axis of the trench where the depth of trench exceeds 5 ft. This measurement includes all required trench protection, including trench ends.
4.	PAYMENT The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Trench Excavation Protection." This price is full compensation for excavation and backfill required for excavation protection; furnishing, placing, and removing shoring, sheeting, or bracing; de-watering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

Item 423

Retaining Walls



1. DESCRIPTION

Furnish, construct, and install retaining walls.

2. MATERIALS

2.1. General. Furnish materials in accordance with the following:

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete,"
- Item 445, "Galvanizing,"
- Item 458, "Waterproofing Membranes for Structures," and
- Item 556, "Pipe Underdrains."

Use concrete for retaining walls that conforms to the requirements of Table 1 unless otherwise shown on the plans.

Table 1
Concrete for Retaining Walls

Application	Concrete
Cast-in-place, non-reinforced	Class A
Cast-in-place, reinforced	Class C
Precast	Class H, $f'_c = 4,000$ psi

Furnish concrete for machine-made concrete block units in accordance with ASTM C90, Class 1, Type II, except the minimum 28-day compressive strength must be 4,000 psi with maximum moisture absorption of 7%.

Provide Type 1 filter fabric in accordance with [DMS-6200](#), "Filter Fabric." Provide filter fabric rated as UV-resistant when used as part of the exposed facing for a temporary wall.

Joint fillers, pads, waterstops, and other incidental materials must be as shown on the plans or approved by the Engineer.

Epoxy coat all steel used in concrete panels and coping including connectors, dowels, stirrups, and reinforcing steel when the plans call for epoxy coating of steel earth reinforcements.

2.2. Definitions. This Item uses the following terms:

- **Permanent Wall.** A retaining wall with a design service life of 75 years. All walls are presumed to be permanent walls unless otherwise specified on the plans.
- **Temporary Wall.** A retaining wall so designated by description, with a design service life of 3 years.
- **Mechanically Stabilized Earth (MSE) Wall.** A wall consisting of a volume of select backfill with tensile earth reinforcement elements distributed throughout. Permanent MSE walls use a precast concrete panel as a facing element. Temporary MSE walls use welded wire fabric with filter fabric backing as a facing element.

- Concrete Block Wall. A retaining wall that uses machine-made, precast concrete block units as facing elements. The walls may use a volume of select fill with tensile earth reinforcements distributed throughout, or may use only the facing unit and unit fill weight for support.

2.3. Fabrication.

2.3.1. Cast-in-Place. Meet Item 420, "Concrete Substructures."

2.3.2. Formed Precast. Meet Item 424, "Precast Concrete Structural Members (Fabrication)."

2.3.3. Machine-Made Precast. Furnish machine-made concrete block units in accordance with ASTM C90, sampled and tested in accordance with ASTM C140. Furnish units with molded dimensions within 1/8 in. of specified dimensions, except height must be within 1/16 in.

2.4. Backfill.

2.4.1. Non-Select. Furnish non-select backfill for walls other than temporary and permanent MSE and concrete block walls as indicated on the plans. Non-select fill will meet Item 132, "Embankment," of the type specified on the plans. Provide material with a maximum plasticity index of 30 if no type is specified as determined by [Tex-106-E](#).

2.4.2. Select. Select backfill is required in specific areas of permanent and temporary MSE and concrete block-type retaining walls. Provide select backfill that is free from organic or otherwise deleterious materials and that conforms to the gradation limits shown in Table 2 as determined by [Tex-401-A](#).

Provide backfill that does not contain shale, caliche, or other soft, poor-durability coarse aggregate particles. Reclaimed Asphalt Pavement (RAP) is not allowed. Crushed Concrete or manufactured sand is allowed for temporary walls with a service life of 3 years or less. Test each source of backfill for durability/soundness using [Tex-411-A](#), 5-cycle magnesium sulfate soundness. Backfill material with a maximum 5-cycle soundness loss exceeding 25% will be rejected. Alternately, [Tex-461-A](#), Micro-Deval abrasion may be used if the corresponding results show loss is not greater than 20%, otherwise [Tex-411-A](#) governs aggregate verification.

Type AS, BS, and DS particles larger than 1/4 in. must be angular or completely crushed. Provide mechanically crushed gravel or stone backfill. Gravel from each aggregate source will have a minimum of 95% two or more mechanically induced crushed faces, as [Tex-460-A](#), Part I determines. Rounded rock or rounded gravel is not allowed. Natural sand meeting the requirements of this Section is permitted for use.

Table 2
Select Backfill Gradation Limits

Type	Sieve Size	Percent Retained
AS	3"	0
	1/2"	50–100
	#4	See Note
	#40	85–100
	#200	95–100
BS	3"	0
	#4	See Note
	#40	40–100
	#200	85–100
CS	3"	0
	#4	See Note
	#200	75–100
DS	3"	0
	3/8"	85–100
	#200	95–100

Note—Use No. 4 sieve for determination of rock backfill as described in this main paragraph, "Backfill."

When the backfill gradation results in 85% or more material retained on the No. 4 sieve, the backfill will be considered rock backfill. All Type DS backfill is considered rock backfill.

In addition to the requirements for Type CS select fill, the fraction finer than the No. 200 sieve must have a Plasticity Index (PI) in accordance with [Tex-106-E](#) not greater than 6.

Furnish Type BS backfill for permanent walls; Type CS backfill for temporary walls; and Type DS backfill for areas of walls subject to inundation unless otherwise shown on the plans, or below the 100-year flood elevation as noted on the plans.

Furnish backfill meeting the requirements of this Section but with a maximum particle size of 3/4 in. when nonmetallic or epoxy coated earth reinforcements are used.

- 2.4.3. Drainage Aggregate. Use drainage aggregate to fill the void within concrete block units and in the zone 1 ft. behind the units. Provide drainage aggregate that is free from organic or otherwise deleterious materials and that conforms to the gradation limits in Table 3 as [Tex-110-E](#) determines.

Table 3
Drainage Aggregate Gradation Limits

Sieve Size	Percent Retained
1"	0
3/4"	25–50
1/2"	50–100
#4	75–100

- 2.4.4. Cement-Stabilized Backfill. Use cement-stabilized backfill when required or as approved. Stabilize Type CS backfill with 5% hydraulic cement by dry weight of the backfill material. Use a stationary plant to thoroughly mix the backfill material, cement, and water. Place and compact the backfill within 2 hours of mixing. Provide special drainage provisions when cement-stabilized backfill is used, as shown on the plans.
- 2.4.5. Electrochemical. Provide backfill meeting the following additional requirements for permanent retaining wall systems using galvanized metallic earth reinforcements:
- The pH is between 5.5 and 10.0 as [Tex-128-E](#) determines.
 - Resistivity is more than 3,000 ohm-cm as [Tex-129-E](#) determines.
 - Material with resistivity between 1,500 and 3,000 ohm-cm may be used if the chloride content is less than 100 ppm and the sulfate content is less than 200 ppm as [Tex-620-J](#) determines.

Perform electrochemical testing on the raw, unstabilized backfill material when cement-stabilized backfill is used.

- 2.5. Earth Reinforcements. Furnish earth reinforcements that meet the design requirements. Galvanize or epoxy coat all steel elements for permanent walls in contact with soil. Epoxy coat in accordance with Item 440, "Reinforcement for Concrete," except provide a minimum 18-mil coating thickness. Epoxy coat the reinforcing only when shown on the plans or as approved. Use connection hardware that is likewise nonmetallic or epoxy coated when using nonmetallic or epoxy coated earth reinforcements.

3. CONSTRUCTION

- 3.1. General. Construct retaining walls in accordance with details shown on the plans, on the approved working drawings, and to the pertinent requirements of the following Items:

- Item 110, "Excavation"
- Item 132, "Embankment"
- Item 400, "Excavation and Backfill for Structures"
- Item 420, "Concrete Substructures"
- Item 458, "Waterproofing Membranes for Structures"
- Item 556, "Pipe Underdrains"

Construct required piling or drilled shafts in accordance with the pertinent specification.

- 3.2. Options. When optional design details are shown on the plans, the Contractor is required to use the same facing design within an area of continuous retaining walls.

Provide drawings for review indicating the proposed design arrangement when proposing the use of 2 or more systems.

- 3.3. Working Drawings. When proprietary wall systems are used for permanent or temporary walls, submit casting drawings, construction drawings, and design calculations bearing the seal of a licensed professional engineer for review and approval following the Department's *Guide to Electronic Shop Drawing Submittal* process. Upon completion of construction, submit a set of reproducible as-built drawings.

- 3.3.1. Casting Drawings. Include all information necessary for casting wall elements, including railing and coping when prefabricated. Show shape and dimensions of panels; size, quantity, and details of the reinforcing steel; quantity, type, size, and details of connection and lifting hardware; and additional necessary details.

- 3.3.2. Construction Drawings. Include a numbered panel layout showing horizontal and vertical alignment of the walls as well as the existing and proposed groundlines. Include all information needed to erect the walls, including the proposed leveling pad elevations; the type and details of the soil reinforcing system (if applicable); the details and manufacturer of all pads, fillers, and filter fabric; the limits and dimensions of structural backfill; details necessary to incorporate coping, railing, inlets, drainage, and electrical conduit; and additional necessary details.

Leveling pad elevations may vary from the elevations shown on the plans. Provide at least 1 ft. of cover from the top of the leveling pad to finish grade unless a different minimum cover or a specified minimum leveling pad elevation is shown.

- 3.3.3. Design Calculations. Include calculations covering the range of heights and loading conditions on the project. Calculations for both internal and external stability as described on the plans will be required. Include a summary of all design parameters used; material types, strength values, and assumed allowables; loads and loading combinations; and factor-of-safety parameters.

- 3.4. Permanent MSE Walls. Grade the foundation for the structure level to a width equal or exceeding the length of the reinforcing system. Perform proof rolling on retaining wall foundation area to identify any loose, soft, or unsuitable materials in accordance with Item 216, "Proof Rolling." Material not meeting a maximum rut depth of 1 in. per pass of pneumatic tire roller should continue to be rolled or removed and replaced with suitable material. Pneumatic tire rolling will be waived for portions of wall with a reinforcement length of 8'; for these conditions proof rolling will be required with a smooth-wheeled vibratory roller or other approved roller.

Place drilled shafts and piling located within the MSE volume before construction of the wall. Place any required pipe underdrain before construction of the wall. Complete MSE wall construction before construction of abutment caps and abutment wing walls. Completion of walls and abutment should be in conjunction with project phasing or to allow for completion of walls that meets the proper placement and compaction at abutments.

Place the concrete leveling pad as shown on the construction drawings. Provide a wood float finish, and wait a minimum of 24 hr. before beginning panel erection. No curing or strength testing of the leveling pad concrete is required.

Shim the first row of panels as necessary to achieve correct alignment. Use plastic shims or other material that will not deteriorate. Remove and replace the leveling pad or provide a grout level-up as directed if the required shim height exceeds 1 in.

Place filter fabric behind the wall along the joint between the leveling pad and the panels. Grout areas where filter fabric spans more than 6 in. at leveling pad steps.

Place and compact fill material over the leveling pad to an elevation even with or above the surrounding ground after backfilling the first row of panels. Do not allow water to accumulate and stand at the base of the wall.

Place filter fabric behind all wall joints and at the intersection of retaining walls with other structures, including riprap. Cover joints at least 6 in. on each side and use adhesive to hold the filter fabric in place.

Exercise care while lifting, setting, and aligning panels to prevent damage to the panels. Discontinue any operation that results in chipping, spalling, or cracking of panels. Remove and replace damaged panels, or repair as approved by the Engineer.

Provide external bracing for the initial row of panels. Use wooden wedges, clamps, or other means necessary to maintain position and stability of panels during placement and compaction of backfill. Remove wooden wedges as soon as the panel or coping above the wedged element is erected and backfilled. Remove all wedges after completing the wall.

Review plumbness and position of each row of panels before placing the subsequent row. Remove and rebuild any portion of the wall that is out of tolerance. Modify panel batter and bracing, and backfill material, placement, and compaction methods as required to maintain wall tolerances.

Construct walls to a local vertical and horizontal alignment tolerance of 3/4 in. when measured along a 10-ft. straightedge relative to vertical and horizontal wall control line. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 1/2 in. per 10 ft. of wall height. Construct walls so the maximum offset at any panel joint is between 3/8 in. and 3/4 in. and no joint is open to the extent the filter fabric is visible from the front of the wall.

Place backfill to closely follow the erection of each row of panels. Place the select and embankment backfill to the same elevation where possible, and operate the compaction equipment over the interface. Do not create a continuous, distinct, vertical joint between the select and embankment backfill. Complete the embankment after construction of the retaining wall.

Maintain the stability of the interface area between the existing ground and the select fill when building a wall against existing ground. Remove and recompact any material that loosens, caves, or fails.

Compact backfill to provide at least 95% of density determined in accordance with [Tex-114-E](#). Field density determination will be made in accordance with [Tex-115-E](#).

Sprinkle backfill as required to ensure adequate uniformly distributed moisture in each lift before and during compaction. Place fill in lifts of 8 in. or less (loose measurement). Place fill in a manner that avoids segregation of the fill. Decrease the lift thickness if necessary to obtain the required compaction. Use hand-operated or walk-behind compaction equipment in the 3 ft. wide strip adjacent to the wall panels. Do not displace panels or distort or damage the reinforcement system during compaction. Modify backfill material, placement, and compaction methods as necessary to meet density requirements while maintaining wall tolerances.

Place rock backfill or material the Engineer determines too coarse for density testing in accordance with Section 132.3.4.1., "Ordinary Compaction."

Place and compact the backfill to the reinforcement level, at each earth reinforcement level, before placing the reinforcement. Place earth reinforcements perpendicular to the face of the wall. Remove slack in connections before placing backfill. Pre-tension each layer of reinforcement to remove slack before placing backfill for systems using nonmetallic earth reinforcements. Use devices capable of mechanically applying and holding the required force. Do not operate tracked equipment directly on any reinforcement.

Cover the rock backfill with filter fabric before placing the 2 ft. of backfill immediately below the pavement structure or top of wall when rock backfill is used. Overlap the fabric at least 18 in. at splices, and extend it past the edge of the rock backfill at least 18 in. Use backfill that contains sufficient fines to fill the voids in a compacted state above the filter fabric. Place a horizontal layer of filter fabric as noted above when transitioning from rock backfill to finer grained backfill anywhere within the wall volume.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace any portion of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.5. Temporary MSE Walls. Provide a facing system rigid enough to maintain a smooth and straight wall face both during and after construction.

Grade and compact the foundation for the structure as described in Section 423.3.4., "Permanent MSE Walls."

Place earth reinforcement and facing system in accordance with the approved working drawings. Backfill the 2-ft. zone immediately behind the facing with clean, coarse rock meeting the requirements of Coarse Aggregate Grade 1, 2, or 3 of Item 421, "Hydraulic Cement Concrete," or of Type DS backfill as described in Section 423.2.4.2., "Select." Cement-stabilized backfill as described in Section 423.2.4.4., "Cement-Stabilized Backfill," may be used in place of the coarse rock.

Place and compact backfill in accordance with Section 423.3.4., "Permanent MSE Walls."

Construct walls to a vertical and horizontal alignment tolerance of 3 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 2 in. per 10 ft. of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements and filter fabric with no gaps in the facing or fabric.

Prevent surface water or rainwater from damaging the retaining walls during and after construction. Place temporary berms or curbs, shape the backfill, or use other approved methods to prevent water from flowing

against or over the wall face. Remove and replace any portion of the wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.6. Concrete Block Retaining Walls. The concrete block units may be sampled and tested by the Engineer before shipment or upon delivery to the construction site. Display for approval, samples of block units indicating the color, texture, and finish. Store, transport, and handle all block units carefully to prevent cracking or damage.

Grade and compact the foundation for the structure, and place the leveling pad as described in Section 423.3.4., "Permanent MSE Walls."

Place the concrete block facing units in accordance with the approved working drawings. Fill the voids within the units and fill the 1-ft. zone immediately behind the facing with drainage aggregate as described in Section 423.2.4.3., "Drainage Aggregate." Systems tested without unit fill may omit the fill as indicated on the approved drawings. Systems with approved filter fabric details may omit the drainage aggregate in the 1-ft. zone immediately behind the facing.

Place reinforcements and backfill for walls using earth reinforcements in accordance with the requirements of Section 423.3.4., "Permanent MSE Walls." Pay particular attention to the connection details of the earth reinforcements to the concrete block units.

Construct walls to a vertical and horizontal alignment tolerance of 1-1/2 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (deviation from the vertical or battered control line, top to bottom) of 1 in. per 10 feet of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements with maximum 1/4-in. gaps between block units.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace all portions of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

4. MEASUREMENT

This Item will be measured by the square foot of the front surface area of the wall. Unless otherwise shown on the plans, the area will be measured from 1 ft. below finished grade of the ground line on the face of the exterior wall to the top of the wall including any coping required (not including railing).

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Retaining Walls" of the type or special surface finish specified. This price is full compensation for excavation in back of retaining walls and for footings; furnishing and placing footings, leveling pads, copings, and traffic railing foundations; furnishing, placing, and compacting backfill (except in embankment areas), including cement for stabilization; proof rolling; furnishing and placing concrete, reinforcing steel, waterproofing material, filter material and drain pipe, joint material, water stop, and filter fabric when required; fabricating, curing, and finishing all panels; furnishing and placing earth reinforcement, anchorage systems, and fasteners; wall erection; and equipment, labor, tools, and incidentals.

Retaining wall backfill areas that are also in embankment areas will be considered part of the quantities measured under Item 132, "Embankment" and payment will be included in the contract costs and not be paid for separately.

When drilled shafts are required, they will be measured as specified in Item 416, "Drilled Shaft Foundations" and payment will be included in the contract costs and not be paid for separately. When piling is required, it will be measured as specified on the plans for piling of the appropriate type and payment will be included in the contract costs and not be paid for separately.

Item 440

Reinforcement for Concrete



1. DESCRIPTION

Furnish and place reinforcement of the type, size, and details shown on the plans.

2. MATERIALS

Use deformed steel bar reinforcement unless otherwise specified or allowed.

- 2.1. Approved Mills. Before furnishing steel, producing mills of reinforcing steel for the Department must be pre-approved in accordance with [DMS-7320](#), "Qualification Procedure for Reinforcing Steel Producing Mills," by the Construction Division. The Department's MPL has a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

Contact the Construction Division with the name and location of the producing mill for stainless reinforcing steel, low carbon/chromium reinforcing steel, or dual-coated reinforcing steel at least 4 weeks before ordering any material.

- 2.2. Deformed Steel Bar Reinforcement. Provide deformed reinforcing steel conforming to one of the following:

- ASTM A615, Grades 60, 75, or 80;
- ASTM A996, Type A, Grade 60;
- ASTM A996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A706, Grades 60 or 80.

Provide the grade of reinforcing steel shown on the plans. Provide Grade 60 if no grade is shown.

The nominal size, area, and weight of reinforcing steel bars this Item covers are shown in Table 1.

Table 1
Size, Area, and Weight of Reinforcing Steel Bars

Bar Size Number (in.)	Diameter (in.)	Area (sq. in.)	Weight per Foot (lbs.)
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.650
18	2.257	4.00	13.60

- 2.3. Smooth Steel Bar Reinforcement. Provide smooth bars for concrete pavement with a yield strength of at least 60 ksi and meeting ASTM A615. Provide steel conforming to ASTM A615 or meet the physical requirements of ASTM A36 for smooth bars that are larger than No. 3. Designate smooth bars by size number up to No. 4 and by diameter in inches above No. 4.

- 2.4. Spiral Reinforcement. Provide bars or wire for spiral reinforcement of the grade and minimum size or gauge shown on the plans.

Provide smooth or deformed wire conforming to ASTM A1064. Provide bars conforming to ASTM A615; ASTM A996, Type A; or ASTM A675, Grade 80, meeting dimensional requirements of ASTM A615.

- 2.5. Weldable Reinforcing Steel. Provide reinforcing steel conforming to ASTM A706 or with a maximum carbon equivalent (C.E.) of 0.55% if welding of reinforcing steel is required or desired. Provide a report showing the percentages of elements necessary to establish C.E. for reinforcing steel that does not meet ASTM A706, in order to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Section 448.4.2.1.1., "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

Do not weld stainless reinforcing steel without permission from the Engineer. Provide stainless reinforcing steel suitable for welding, if required, and submit welding procedures and electrodes to the Engineer for approval.

- 2.6. Welded Wire Reinforcement. Provide welded wire reinforcement (WWR) conforming to ASTM A1064. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W."

Designate WWR as shown in the following example: 6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Table 2
Wire Size Number, Diameter, and Area

Size Number (in.)	Diameter (in.)	Area (sq. in.)
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
2.9	0.192	0.035
2.5	0.178	0.025
2	0.160	0.020
1.4	0.134	0.014
1.2	0.124	0.012
0.5	0.080	0.005

Note—Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Fractional sizes between the sizes listed above are also available and acceptable for use.

- 2.7. Epoxy Coating. Provide epoxy coated reinforcing steel as shown on the plans. Before furnishing epoxy coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with [DMS-7330](#), "Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators." The Department's MPL has a list of approved applicators.

Furnish coated reinforcing steel meeting the requirements in Table 3.

Table 3
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or WWR	ASTM A884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with [DMS-8130](#), "Epoxy Powder Coating for Reinforcing Steel." Patch no more than 1/4-in. total length in any foot at the applicator's plant.

Maintain identification of all reinforcing steel throughout the coating and fabrication process and until delivery to the project site.

Furnish 1 copy of a written certification verifying the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

- 2.8. Mechanical Couplers. Use couplers of the type specified in [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel," Article 4510.5.A, "General Requirements," when mechanical splices in reinforcing steel bars are shown on the plans.

Furnish only couplers pre-qualified in accordance with [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel." Ensure sleeve-wedge type couplers are not used on coated reinforcing. Sample and test couplers for use on individual projects in accordance with [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel." Furnish couplers only at locations shown on the plans.

Furnish couplers for stainless reinforcing steel with the same alloy designation as the reinforcing steel.

- 2.9. Fibers. Supply fibers conforming to [DMS-4550](#) "Fibers for Concrete" at the minimum dosage listed in the Department's MPL, when allowed by the plans. Use non-metallic fibers when shown on the plans.
- 2.10. Stainless Reinforcing Steel. Provide deformed steel bars of the types listed in Table 4 and conforming to ASTM A955, Grade 60 or higher when stainless reinforcing steel is required on the plans.

Table 4
Acceptable Types of Deformed Stainless Steel Bar

UNS Designation	S31653	S31803	S24100	S32304
AISI Type	316LN	2205	XM-28	2304

- 2.11. Low Carbon/Chromium Reinforcing Steel. Provide deformed steel bars conforming to ASTM A1035, Grade 100 when low carbon/chromium reinforcing steel is required on the plans.
- 2.12. Dual-Coated Reinforcing Steel. Provide deformed bars conforming to ASTM A1055, Grade 60 or higher when dual-coated reinforcing steel is required on the plans.
- 2.13. Glass Fiber Reinforced Polymer Bars (GFRP). Provide bars conforming to the AASHTO LRFD *Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings*, Section 4, "Material Specifications" when GFRP bars are required on the plans. Provide sample certification demonstrating the GFRP bar supplier has produced bar that meets the Material Specifications 2 mo. before fabrication. Furnish certification upon shipment that the GFRP bar supplied meets the Material Specifications.

3. CONSTRUCTION

- 3.1. Bending. Fabricate reinforcing steel bars as prescribed in the CRSI *Manual of Standard Practice* to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the Department. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 5.

Table 5
Minimum Inside Diameter of Bar Bends

Bend	Bar Size Number (in.)	Pin Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	4d
	6, 7, 8	6d
Bends in main bars and in secondary bars not covered above	3 through 8	6d
	9, 10, 11	8d
	14, 18	10d

Bend-test representative specimens as described for smaller bars in the applicable ASTM specification where bending No. 14 or No. 18 Grade 60 bars is required. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

Bend stainless reinforcing steel in accordance with ASTM A955.

- 3.2. Tolerances. Fabrication tolerances for bars are shown in Figure 1.

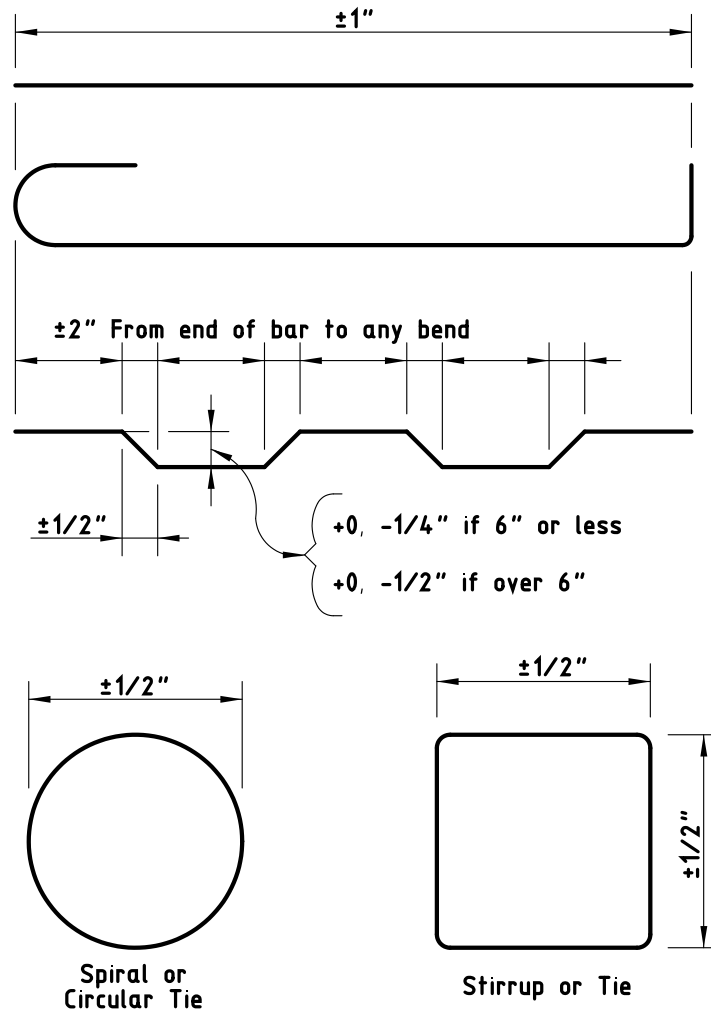


Figure 1
Fabrication Tolerances for Bars

- 3.3. **Storage.** Store reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

Do not allow stainless reinforcing steel to be in direct contact with uncoated reinforcing steel, nor with galvanized reinforcing steel. This does not apply to stainless steel wires and ties. Store stainless reinforcing steel separately, off the ground on wooden supports.

- 3.4. **Splices.** Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs no more than 15 in. in thickness, columns, walls, and parapets.

- Do not splice bars less than 30 ft. in plan length unless otherwise approved. For bars exceeding 30 ft. in plan length, the distance center-to-center of splices must be at least 30 ft. minus 1 splice length, with no more than 1 individual bar length less than 10 ft. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 6. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

Table 6
Minimum Lap Requirements for Steel Bar Sizes through No. 11

Bar Size Number (in.)	Uncoated Lap Length	Coated Lap Length
3	1 ft. 4 in.	2 ft. 0 in.
4	1 ft. 9 in.	2 ft. 8 in.
5	2 ft. 2 in.	3 ft. 3 in.
6	2 ft. 7 in.	3 ft. 11 in.
7	3 ft. 5 in.	5 ft. 2 in.
8	4 ft. 6 in.	6 ft. 9 in.
9	5 ft. 8 in.	8 ft. 6 in.
10	7 ft. 3 in.	10 ft. 11 in.
11	8 ft. 11 in.	13 ft. 5 in.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice WWR using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 6 are permitted.
- Lap the existing longitudinal bars with the new bars as shown in Table 6 for box culvert extensions with less than 1 ft. of fill. Lap at least 1 ft. 0 in. for extensions with more than 1 ft. of fill.
- Ensure welded splices conform to the requirements of the plans and of Item 448, "Structural Field Welding." Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.
- Install mechanical coupling devices in accordance with the manufacturer's recommendations at locations shown on the plans. Protect threaded male or female connections, and ensure the threaded connections are clean when making the connection. Do not repair damaged threads.
- Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

3.5. Placing. Place reinforcement as near as possible to the position shown on the plans. Do not vary bars from plan placement by more than 1/12 of the spacing between bars in the plane of the bar parallel to the nearest surface of concrete. Do not vary bars from plan placement by more than 1/4 in in the plane of the bar perpendicular to the nearest surface of concrete. Provide a minimum 1-in. clear cover of concrete to the nearest surface of bar unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is -0, +1/2 in.

Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and keep the reinforcement at the proper distance from the forms. Provide bar supports in accordance with the *CRSI Manual of Standard Practice*. Use Class 1 supports, approved plastic bar supports, precast mortar, or concrete blocks when supports are in contact with removable or stay-in-place forms. Use Class 3 supports in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

Use Class 1A supports with epoxy coated reinforcing steel. Provide epoxy or plastic coated tie wires and clips for use with epoxy coated reinforcing steel.

Use mortar or concrete with a minimum compressive strength of 5,000 psi for precast bar supports. Provide a suitable tie wire in each block for anchoring to the bar.

Place individual bar supports in rows at 4-ft. maximum spacing in each direction. Place continuous type bar supports at 4-ft. maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and storm drains is not cause for rejection.

Tie reinforcement for bridge slabs and top slabs of direct traffic culverts at all intersections, except tie only alternate intersections where spacing is less than 1 ft. in each direction. Tie the bars at enough intersections to provide a rigid cage of reinforcement for reinforcement cages for other structural members. Fasten mats of WWR securely at the ends and edges.

Clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement before concrete placement. Do not place concrete until authorized.

Stop placement until corrective measures are taken if reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement.

3.6. Handling, Placing, and Repairing Epoxy Coated Reinforcing Steel.

3.6.1. Handling. Provide systems for handling coated reinforcing steel with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.

3.6.2. Placing. Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 440.3.6.3., "Repairing Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6 in. beyond the weld limits before welding and 2 in. beyond the limits of the coupler before assembly. Clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish after welding or coupling. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

Coat the splice area after cleaning with epoxy repair material to a thickness of 7 to 17 mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3.6.3. Repairing Coating. Use material that complies with the requirements of this Item and ASTM D3963 for repairing of the coating. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. Apply at least the same coating thickness as required for the original coating for areas to be patched. Repair all visible damage to the coating.

Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure they are free from surface contaminants. Make repairs in the shop or field as required.

3.7. Handling and Placing Stainless Reinforcing Steel. Handle, cut, and place stainless reinforcing steel bar using tools that are not used on carbon steel. Do not use carbon steel tools, chains, slings, etc. when handling stainless steel. Use only nylon or polypropylene slings. Cut stainless steel reinforcing using shears, saws, abrasive cutoff wheels, or torches. Remove any thermal oxidation using pickling paste. Do not field bend stainless steel reinforcing without approval.

Use 16 gauge fully annealed stainless steel tie wire conforming to the material properties listed in Section 440.2.10., "Stainless Reinforcing Steel." Support all stainless reinforcing steel on solid plastic, stainless steel, or epoxy coated steel chairs. Do not use uncoated carbon steel chairs in contact with stainless reinforcing steel.

- 3.8. Bending, Handling, Repairing, and Placing GFRP Bars. Fabricate, handle, repair, and place GFRP bars in accordance with the AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings, Section 5, Construction Specifications.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to contract.

501.14. POLYVINYL CHLORIDE (PVC) WATER PIPE

501.14.1. General. Unplasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA C900, sizes 4-in. to 60-in. diameter. In accordance with C900, Section III.A, purchaser options and alternatives shall be provided by the specifier, including working, occasional, and recurring surge pressures, pressure class, or dimension ratio (DR). Purchaser options and alternatives shall be specified in the supplemental conditions, plans, or technical specifications. Laying lengths shall be 20-ft $\pm$ 1-in.

501.14.2. Approvals. PVC water pipe shall be approved by the Underwriters' Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of Texas. PVC water pipe shall also bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

501.14.3. Dimension Ratio. PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in AWWA C900. The pressure classification refers to the maximum hydrostatic pressure to which the pipe shall be subjected in normal operations.

501.14.4. Joints. PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic and in conformance to NSF61. The lubricant shall have no detrimental effect to either gasket or pipe.

501.14.5. Fittings. Fittings for PVC water pipe shall conform to one of the standards Table 501.14.5.(a) PVC Water Pipe Fittings unless otherwise specified. Fittings joints shall be push-on, integrally restrained, or mechanical. Bolts and nuts for mechanical and integrally restrained fittings joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints (Type 3) or shall be stainless steel in accordance with ASTM A304.

Table 501.14.5.(a) PVC Water Pipe Fittings Standards

Standard	Topic
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. for Water
AWWA C153	ANSI Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water—4 in. Through 8 in.
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in. Through 12 in. or Water Distribution

501.14.6. Measurement and Payment Fittings. Measurement for all pipes shall be in linear foot and joints and fittings per each and shall cover all costs to place pipe, joints and fittings in place as shown on the plans. Payment will be included in the contract costs and not be paid for separately. Included shall be all excavation, backfill, and other materials, and all appurtenances for a complete unit.

501.15. POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES)

501.15.1. General. PVC pressure-rated pipe shall conform to the current ASTM D2241, Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

501.15.2. Material. The pipe shall be made of PVC plastic having cell classifications of 12454 or 13343 in accordance with ASTM D1784.

501.15.3. Joints. Joint tightness shall be tested in accordance with ASTM D3139, Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

501.15.4. Testing. All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

501.15.5. Measurement and Payment Fittings. Measurement for all pipes shall be in linear foot and joints per each and shall cover all costs to place pipe, joints and fittings in place as shown on the plans. Payment will be included in the contract costs and not be paid for separately. Included shall be all excavation, backfill, and other materials, and all appurtenances for a complete unit.

Item 502

Barricades, Signs, and Traffic Handling



1.	DESCRIPTION Provide, install, move, replace, maintain, clean, and remove all traffic control devices shown on the plans and as directed.
2.	CONSTRUCTION Comply with the requirements of Article 7.2., "Safety." Implement the traffic control plan (TCP) shown on the plans. Install traffic control devices straight and plumb. Make changes to the TCP only as approved. Minor adjustments to meet field conditions are allowed. Submit Contractor-proposed TCP changes, signed and sealed by a licensed professional engineer, for approval. The Engineer may develop, sign, and seal Contractor-proposed changes. Changes must conform to guidelines established in the TMUTCD using approved products from the Department's Compliant Work Zone Traffic Control Device List. Maintain traffic control devices by taking corrective action when notified. Corrective actions include, but are not limited to, cleaning, replacing, straightening, covering, and removing devices. Maintain the devices such that they are properly positioned and spaced, legible, and have retroreflective characteristics that meet requirements day or night and in all weather conditions. The Engineer may authorize or direct in writing the removal or relocation of project limit advance warning signs. When project limit advance warning signs are removed before final acceptance, provide traffic control in accordance with the TMUTCD for minor operations as approved. Remove all traffic control devices upon completion of the work as shown on the plans or as directed.
3.	MEASUREMENT Barricades, Signs, and Traffic Handling will be measured by the month. Law enforcement personnel with patrol vehicles will be measured by the hour for each person.
4.	PAYMENT 4.1. Barricades, Signs, and Traffic Handling. Except for Contracts with callout work and work orders, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" payment will be included in the contract costs and not be paid for separately for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" payment will be included in the contract costs and not be paid for separately for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals.

When the plans establish bid items for particular work in the TCP, that work will be measured and payment will be included in the contract costs and not be paid for separately.

- 4.1.1. Total Payment Quantity. An overrun of the plans quantity for this Item will not be allowed for approving designs; testing; material shortages; closed construction seasons; curing periods; establishment, performance, test, and maintenance periods; failure to complete the work in the number of months allotted; nor delays caused directly or indirectly by requirements of the Contract.
- 4.1.2. Contracts with Callout Work and Work Orders. The work performed and the materials furnished with this Item and measured as provided under "Measurement," will be considered subsidiary to pertinent Items.
- 4.2. Law Enforcement Personnel. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid by Contractor force account for "Law Enforcement Personnel." This price is full compensation for furnishing all labor, materials, supplies, equipment, patrol vehicle, fees, and incidentals necessary to complete the work as directed. Payment will be included in the contract costs and not be paid for separately.

502.1. MANHOLES

502.1.1. Manhole Materials. Manholes shall be fabricated in different configurations to meet the specific needs required in the water or wastewater or storm water system.

502.1.1.1. Precast Reinforced Concrete Manhole Sections. These specifications cover precast reinforced concrete manhole sections, which shall conform to ASTM C478 Precast Reinforced Concrete Manhole Sections, with the following additions:

- (1) Aggregates for the concrete shall comply with requirements of ASTM C33 Concrete Aggregates.
- (2) Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals

502.1.1.1.1. Joints. Joints shall conform to the joint specification ASTM C443 Joints for Concrete Pipe & Manholes, Using Rubber Gaskets. All joints shall have rubber gaskets. Rubber gaskets shall meet the requirements of [Item 501.5.4.1. Rubber Gaskets](#).

502.1.1.1.2. Coatings and Linings. Coatings and linings called for in the specifications or shown on the plans shall meet the requirements as specified by the OWNER and shall be installed or applied by the manufacturer. Add mixtures may be required as per OWNER specification.

502.1.1.1.3. Lifting Devices. Manhole sections and cones may be furnished with lift lugs or lift holes. If lift lugs are provided, they shall be 180° apart. Cast-in-place nuts must have clean threads capable of inserting lug bolts. OWNER shall approve the lift lug design. If lift holes are provided, they shall be plugged with a nonmetallic nonshrink grout approved by the OWNER. Field repairs shall not be allowed without OWNER approval.

502.1.1.1.4. Rejection. Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or having defects as follows:

- (1) Variations in any dimensions exceeding the permissible variation prescribed.
- (2) A piece broken out of the bell, spigot, tongue or groove in such size that the watertightness of the joint could be impaired.
- (3) Any shattering or flaking of concrete or other conditions indicating an improper concrete mix.
- (4) Lack of uniformity in placement steel which might preclude all joints being typical of those tested.
- (5) Cracks sufficient to impair the strength, durability, or serviceability of the pipe.
- (6) Joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.

502.1.1.2. Fiberglass Manholes. Fiberglass manholes shall conform to all ASTM standards governing plastic laminations and ASTM D3753, Glass-Fiber-Reinforced Polyester Manholes and Wetwells, with supplementary details or additions as set forth in these specifications. See Standard Drawing 5040.

502.1.1.2.1. Manufacturing. The barrel and cone shall each be produced in a continuous manufacturing process that insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a reinforced glass resin joint resulting in a one-piece unit. Field made joints shall not be acceptable.

502.1.1.2.2. Manhole Configuration. The manhole shall be a circular cylinder with a minimum internal diameter of 4-ft. The cone of the manhole shall have a bearing surface wide enough to facilitate the placement of adjustment rings. The ring and cover shall not be placed directly on the manhole. The manway reducer shall be concentric with respect to the manhole cylinder. Eccentric manway reducers shall not be permitted. Manhole gaskets shall be used to ensure a watertight assembly.

502.1.1.2.3. Testing. All tests included in Glass Fiber-Reinforced Polyester Manholes, ASTM D3753, shall be required. Manufacturer shall provide OWNER a product certification if requested. This certification shall confirm the fiberglass manhole provided is in compliance with the testing requirements outlined in the ASTM standard.

502.1.1.2.4. Rejection. Any fiberglass manhole shall be subject to rejection for failure to conform to any of the requirements of these specifications. Any manhole found to be defective or damaged resulting from improper handling or installation shall be removed and replaced at no additional expense to the OWNER. Patching shall not be acceptable.

502.1.2. Grade Adjustment Risers. Casting shall be raised to final grade adjustment of access covers and frame assemblies made using adjustment risers. Risers may be concrete, polyethylene, metal, or rubber meeting requirements below or other materials as approved by the OWNER. OWNER shall specify material. Adjustment risers shall be tested to assure compliance with impact and loading requirements of the AASHTO Standard Specification for Highway Bridges. To determine the suitability of a specific ring or frame and to ensure a proper fit, the dimensions of the existing frames, grates and covers must be verified by the CONTRACTOR and provided to the supplier prior to fabrication of the adjustment rings and frames.

Installed grade adjustment risers and riser assemblies shall fit within the existing casting without interference, cause no binding to the manhole lid, be immobile and watertight. Manhole lids shall have bearing on all of the surface of inner ring(s).

502.1.2.1. Precast Concrete Adjustment Riser. Concrete adjustment risers shall be precast, reinforced concrete meeting requirements of ASTM C478 Precast Reinforced Concrete Manhole Sections. Preformed flexible gaskets shall be used below each riser.

502.1.2.2. HDPE Adjustment Riser. The HDPE adjustment risers shall be manufactured from high density polyethylene plastic as identified in ASTM D1248 Polyethylene Plastic Molding and Extrusion Materials. They may be molded from 100% recycled HDPE material or have other recycled HDPE material content. Material properties shall be tested and qualified for usage according to the test methods in ASTM D1248. HDPE risers shall be manufactured using the injection molding process as defined by the Society of Plastic Engineers.

502.1.2.3. Metal Adjustment Riser.

502.1.2.3.1. Steel. Inner riser rings shall consist of $\frac{3}{4}$ " thick domestic steel meeting the requirements of ASTM A36 Carbon Structural Steel. Intermediate and outer rings shall be one of the combinations indicated in Table 502.1.2.3.1.(a) Steel Adjustment Risers, as specified by the OWNER.

Table 502.1.2.3.1.(a) Steel Adjustment Risers

Intermediate ring	Outer ring	Type
none	ASTM A36 steel $\frac{1}{2}$ " thick	solid
ASTM A36 12-gauge steel	$\frac{1}{2}$ " x $\frac{1}{2}$ " surrounding intermediate ring at finished elevation	solid
none	ASTM A36 steel $\frac{1}{2}$ " thick	Adjustable ¹
ASTM A36 steel $\frac{1}{8}$ " thick	$\frac{1}{2}$ " x $\frac{1}{2}$ " surrounding intermediate ring at finished elevation	Adjustable ¹

1. Adjustment devices for adjustable steel risers shall be fabricated from stainless steel, have a positive lock, and be in line with the lower bearing bar. It shall be capable of adjustment $\pm\frac{3}{8}$ " from nominal.

Rings shall be fabricated to $\pm\frac{1}{16}$ " concentricity. The outer riser ring shall have an inside diameter no greater than $\frac{3}{16}$ " larger than the outside diameter of the manhole lid. All materials shall be coated as specified by OWNER.

Certified welders shall securely weld rings in accordance with American Welding Society D1.5 Bridge Code to prevent differential movement between rings under traffic loads.

502.1.2.3.2. Iron. Gray iron adjustment risers shall be manufactured from iron conforming to ASTM A48 Gray Iron Castings, Class 35B, in accordance with AASHTO M306. Ductile iron adjustment risers shall be manufactured from iron conforming to ASTM A536 Ductile Iron Castings, Grade 7050-05.

502.1.2.4. Rubber Adjustment Riser. The adjustment risers shall be manufactured from a mixture of rubber and appropriate additives to create a flexible product that will not rot, chip or break, and is resistant to moisture, oil and other common automotive chemicals. Product shall be stable under a

wide range of temperatures and resistant to temperature fluctuations. Rubber adjustment risers may be produced with recycled rubber content. Results of the tests listed in Table 502.1.2.4.(a) Rubber Adjustment Riser Tests shall be provided to the OWNER.

Table 502.1.2.4.(a) Rubber Adjustment Riser Tests

Property	ASTM Test Method	Topic
Density	C642	Test Method for Density, Absorption, and Voids in Hardened Concrete
Durometer hardness, molded and interior surfaces	D2240	Rubber Property-Durometer Hardness
Tensile strength	D412	Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
Compression deformation, initial and final	D575	Rubber Properties in Compression
Compression set	D395	Rubber Property-Compression Set
Freeze and thaw when exposed to deicing chemicals	C672	Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
Coefficient of thermal expansion	C531	Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
Weathering (70 hours at 70 C)	D573	Rubber-Deterioration in an Air Oven

502.1.3. Frame and Cover. Frame (Ring) and cover shall meet the requirements of [Item 806.4.1.2](#). Iron Castings.

502.1.4. Manhole Construction. TCEQ regulations shall take precedence in the case of conflict between these specifications and TCEQ regulations.

Manholes shall be of sufficient inside diameters to allow personnel to work within them and to allow proper joining of the pipes in the manhole wall. Unless otherwise specified, manholes shall have an inside diameter of at least 48-inches.

Manholes constructed in advance of paving projects shall be constructed with the top of the concrete portion of the manhole 23-inches below the final finished grade. The ring and cover shall be placed on a built-up section of approved grade rings and approved sealers between rings and between rings and other materials. Manholes shall be watertight. The type and size, if greater than 4-feet inside diameter, shall be shown on the plans for each location. The CONTRACTOR shall furnish all appropriate equipment and access required for inspection.

Backfilling of manholes shall comply with [Section 504.4](#).

502.1.4.1. Manhole Types and Requirements. Manholes in water lines shall be Cast-In-Place or Precast as described below and as shown in Division 5000 Standard Drawings. Manholes in wastewater service lines may be any of those described below, also shown in Division 5000 Standard Drawings. Manholes in storm sewers shall be Cast-In-Place, Precast, or constructed according to Standard Drawing 6010A-B. Storm sewer junction boxes shall be constructed according to Standard Drawing 6010A-B or constructed according to engineered plans. Manholes may be standard or shallow, as specified by the OWNER.

502.1.4.1.1. Cast-In-Place. The base, wall and cone shall be Class F or Class PF concrete as specified by the OWNER, in conformance with [Item 702](#). Concrete Structures, poured and vibrated to assure a monolithic structure free from infiltration. Typical requirements are shown in Standard

Drawing 5030. Manufacturer shall submit shop drawings for OWNER approval. Construction joints with waterstops must be approved by the OWNER.

502.1.4.1.2. Precast. Precast manholes shall conform to the requirements of [Item 502.1.1.1.](#) Precast Reinforced Concrete Manhole Sections. Typical requirements are shown in Standard Drawing 5020. The base shall be Class F or Class PF concrete as specified by the OWNER, in conformance with [Item 702.](#) Concrete Structures. The precast sections shall be of the bell-and-spigot design incorporating trapped O-ring gaskets in conjunction with premolded joint sealing compound, or tongue-and-groove with a premolded joint sealing compound (water or storm water). Wastewater precast sections shall be sealed using trapped O-rings gaskets in conjunction with premolded joint sealing compound. Premolded joint sealing compound may be used for water line manholes only when approved by the OWNER. Prior to placing each section of manhole riser or cone, the bells and spigots to be joined shall be thoroughly cleaned, the gasket properly placed, lubricated and the joint pushed home. Combination of joints shall be selected to minimize the number of individual segments. Long joints shall be used in the bottom and shorter segments utilized for top adjustments. Lift holes may be used but must be filled with a nonshrink grout after the section is in place. Precast manholes used in floodplains shall require sealed anchor design.

502.1.4.1.3. Fiberglass. Fiberglass manholes shall conform to the requirements of [Item 502.1.1.2.](#) Fiberglass Manholes. The fiberglass portion of the manhole shall be delivered in one piece. Field jointing shall not be permitted. Fiberglass manholes shall be installed in accordance with the manufacturer's recommendation and with supplementary details, additions or exceptions as directed by the OWNER and/or as shown on the plans. Typical requirements are shown in Standard Drawing 5040. The base shall be Class F or Class PF reinforced concrete as required per [Item 702.](#) Concrete Structures as specified by the OWNER. A minimum of 8 holes $\frac{5}{8}$ -in. in diameter shall be drilled equidistantly around the periphery of the manholes at a distance 4-in. from the bottom for use in inserting #4 reinforcing bars to be keyed into the concrete base to prevent the manhole from floating. All holes shall be sealed around the reinforcing steel to prevent leakage.

502.1.4.1.4. Drop. Drop manholes shall be constructed in accordance with details on the plans. Typical requirements are shown in Standard Drawings 5070 and 5080. The basic construction for drop manholes shall be identical to that described for standard manholes preceding with special provisions incorporated to provide drop piping and appurtenances as detailed.

502.1.4.1.5. Pressure Type. Pressure type manholes (sealed manholes) shall be constructed in accordance with Standard Drawing 5050 unless otherwise shown on the plans.

502.1.4.1.6. Standard Manhole. Standard manholes shall be constructed to the proper elevation as required and to a depth of at least 6-ft. above the invert of the main(s) or lateral(s) in the system.

502.1.4.1.7. Shallow Manhole. Shallow manholes shall be constructed for specific locations in a storm sewer system for depth less than 6-ft. when specifically designated on the project plans, or when so directed by the OWNER.

502.1.4.2. Vents. When specified, vents shall be constructed as shown in Standard Drawing 5060 unless the OWNER provides details for vent construction.

502.1.4.3. Invert. The invert of manholes shall be formed in a typical pattern regardless of the wall construction.

502.1.4.3.1. Flow Channel. When specified in the special provisions or in the plans, the pipe shall be laid through the manhole stations where possible, prior to concreting, so that the full depth of the pipe is embedded in concrete to form the flow channel.

502.1.4.3.2. Flow Channel Alternate. Where pipe cannot be used through the manhole due to intersecting flow channels, flow channels equivalent to the top of pipe shall be formed with concrete, then troweled to a smooth, even finish with a steel trowel.

502.1.4.3.3. Manhole Bench. The manhole bench from wall line to flow channels shall be sloped and troweled smooth on a grade of 1-in.-per-foot with a liberal radius applied at flow channel intercepts.

502.1.4.4. First Full Joint. The first full joint of pipe extending from the manhole shall be cradled in concrete to the pipe joint in the same pour as that for the manhole base slab as shown on the plans.

502.1.4.5. Grade Adjustment Risers. Installation of risers shall be shown on the plans. Grade risers and sealers shall be approved by the OWNER. Risers may be of concrete, polyethylene, metal, rubber or other materials meeting the requirements of [Item 502.1.2](#), Grade Adjustment Risers. The minimum number of risers required of the type approved shall be used. The manhole and grade adjustment shall form a watertight assembly. Tapered adjustment risers shall be used to match road grade. The annular space between risers and cone basin, between risers and cover frame, and between multiple risers shall be sealed using an approved sealant. Butyl sealant shall be used for HDPE.

502.1.4.6. Covers. Manhole covers shall be detailed on the plans. Manhole covers of nominal 30-inch or larger diameter are required for all manholes where personnel entry is anticipated. Manholes located within the floodplain shall have gasketed, pressure-type lids and bolted covers, or have another means of preventing inflow.

Installation of covers shall be shown on the plans. For all manhole installations, the manhole covers shall be provided with pick slots or bars in lieu of pick holes. (Pickholes are allowed for stormdrain manholes.) If the rim elevation above surrounding ground is prohibited by land use or other reasons, a cover with a pick slot or bar as described for use in street locations shall be used.

502.1.4.7. Concrete Pad. A 5-ft. by 5-ft. square concrete pad shall be constructed as shown on the plans for manhole installation outside of paved areas.

502.1.4.8. Wastewater Manhole Frame Seals. All newly constructed Wastewater Manholes shall include an Internal Frame Seal as approved by OWNER. All costs for furnishing and installing the seal and extensions shall be included in the applicable Unit Price bid for Wastewater Manholes.

502.1.5. Manhole Testing. Manholes shall be tested by hydrostatic exfiltration or vacuum testing, or other method as approved by TCEQ and determined by the OWNER. Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing.

502.1.5.1. Exfiltration Testing Manholes. The rate of exfiltration for manhole testing shall not exceed 0.025-gallons per foot diameter per foot of manhole depth per hour. Alternative test methods shall ensure compliance with the above allowable leakage. Hydrostatic exfiltration testing shall be performed as follows: All wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water, and maintained full for at least 1-hour. For concrete manholes a wetting period of 24-hours may be used prior to testing in order to allow saturation of the concrete. If the manhole fails the hydrostatic test, the manhole shall be repaired and retested until it passes the test.

502.1.5.2. Vacuum Testing Manholes. Vacuum testing of manholes shall be performed by the CONTRACTOR in compliance with these specifications. All lift holes and exterior joints shall be plugged with a non-shrink grout. No grout shall be placed in horizontal joints prior to testing. All pipes entering the manhole shall be plugged. Stubouts, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn. A minimum 60-in./lb. torque wrench shall be used to tighten the external clamps that secure the test cover to the top of the manhole. The test head shall be placed at the inside of the top of the cone section, and the seal inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches-of-mercury (34-kPa) shall be drawn, and the vacuum pump shut off. With all valves closed, the time for the vacuum to drop to 9-inches-of-mercury (30-kPa) shall not be less than the time indicated in Table 502.1.5.2.(a) Vacuum Drop Minimum Time.

Table 502.1.5.2.(a) Vacuum Drop Minimum Time

Depth of MH (feet)	Manhole Diameter		
	48"	60"	72"
	Minimum Time Required for a Vacuum Drop of 1" Hg (min:sec)		
0 – 20	0:40	0:50	1:00
22	0:44	0:55	1:06
24	0:48	1:00	1:12
26	0:52	1:05	1:18
28	0:56	1:10	1:24
30	1:00	1:15	1:30
See note 1.	0:04	0:05	0:06

1. Additional 2-ft. depths, add indicated time for each 2-ft.

Manholes shall be accepted with relation to vacuum test requirements if they meet the criteria above. Any manhole that fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made. After a successful test, the temporary plugs shall be removed.

502.1.6. Measurement and Payment of Manholes. Measurement for manholes shall be on a per each basis and shall cover all costs for the structure complete in place as designed. Payment will be included in the contract costs and not be paid for separately. Included shall be all excavation, castings, reinforcing steel, concrete, backfill, and other materials, and all appurtenances for a complete and functional unit.

Payment for grade adjustment for existing manholes shall be measured per each manhole and will be included in the contract costs and not be paid for separately.

The payment for extra depth in excess of the basic manhole depth will be included in the contract costs and not be paid for separately.

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including earth excavation, disposal of surplus materials and backfill, all in accordance with the plans and these specifications.

502.3. FIRE HYDRANTS

502.3.1. Materials. Fire hydrants which are to be installed as shown on the plans or to be furnished for general installation shall be dry-barrel traffic model that conform to AWWA C502 Standard for Dry-Barrel Fire Hydrants, except for changes and/or additions specified as follows or as shown on the plans or in the contract specifications. All hydrant components covered by NSF-61 must comply with NSF-61 requirements.

502.3.1.1. Supplementary Details Specified. The type of shut-off may be either of the following:

- (1) Compression type with the flow.
- (2) Compression type against the flow.

The valve action shall provide positive shut-off at minimum closing torque. Wedge action closing gates shall not be permitted, and the scissors type main valves shall not be permitted unless approved by the OWNER.

Inlet connection shall be mechanical joint unless otherwise specified and shall be for a 6-in. cast iron pipe with minimum net valve opening of 5¼-in. unless otherwise specified.

Delivery classification: number and size of pumper and hose nozzles shall be as shown on the plans and contract specifications.

Bury length: ground to bottom of connecting pipe shall be 4-feet or as specified by the OWNER.

Diameter outlet connections: hose and pumper nozzle threads shall be of the size and type shown on the plans.

Gaskets shall be furnished on all nozzle caps and shall be long life, black rubber meeting ASTM D2000, Classification System for Rubber Products in Automotive Applications, or equal.

Unless otherwise specified in the special provisions or in the plans, the operating and nozzle cap nuts shall be tapered pentagon nuts with faces not less than 1-in. high.

Drain valve and outlet: hydrants shall be equipped with a minimum of two drainholes and provided with an automatic and positively operating noncorrodible drain or dip valve so as to drain the hydrant completely when the main valve is shut.

Direction to open is to be specified in the contract specifications. Number of turns to open shall be in accordance with AWWA Standard C502.

The outside of the hydrant shall be thoroughly cleaned and thereafter painted in the shop with one coat of primer. After shop priming, a finish coat of colored paint as specified by OWNER shall be applied to the exterior above ground surfaces.

502.3.1.2. Breakable Type Hydrants. Breakable or Sleeve Type Couplings. The barrel of the hydrant between the base and the nozzle section must be made in two parts connected by a swivel flange or breakable flange which shall permit facing of the nozzles in any desired direction in increments of 45° or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the base of the hydrant.

The materials used for gaskets between the upper and lower barrels and the base and nozzle section shall be compounded to conform to ASTM D2000 or an equal material that shall have OWNER approval prior to substitution unless otherwise specified in the plans.

Provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into the hydrant barrel, and the break shall not occur through the pins or bolts holding the coupling to the stem.

502.3.1.3. Main Valve Seats. Main valve seats shall be of such design that incorrect positioning is impossible.

502.3.1.4. Nozzle Cap Chains. When required by the OWNER, the nozzle cap chains shall be in accordance with AWWA C502 Dry-Barrel Fire Hydrants.

502.3.1.5. Flanges. All flanges other than barrel flanges shall be equipped with mechanical joints. Gland bolts shall be high-strength, low-alloy, corrosion-resistant steel conforming to ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength, Type 3.

502.3.1.6. Operating Stems. The spindle of the operating stem and the stem nuts for hydrants having the operating threads located in the barrel or waterway shall be manganese bronze, Everdur or other high-quality noncorrodible metal. Barrel bolts and nuts shall meet the requirements of ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

All working parts in the waterway, except for sliding stem support mechanisms, shall be bronze-to-bronze or bronze-to-iron unless otherwise specified in the special provisions or in the plans.

502.3.1.7. O-Ring. Hydrant stem packing boxes, where needed, shall be provided with O-ring grooves and sealed with O-rings. O-rings shall be furnished in lieu of stem packing. They shall be of the double O-ring type designed so that the rubber rings shall move against a bronze, stainless steel or other noncorrodible metal surface. O-ring shall be in accordance with ASTM D2000, Classification System for Rubber Products in Automotive Applications.

502.3.1.8. Extensions. Fire hydrants shall be designed to accept a 6 in., 12 in. or 18 in. extension and no more than one extension and maximum of 18 in.

502.3.1.9. Hydrant Heads. The hydrant shall be constructed so that the nozzles may be faced in any desired direction.

502.3.1.10. Drawings. Proposals shall be accompanied by catalogue cuts, photographs or drawings in duplicate showing complete detailed dimensions of the hydrants when requested by the OWNER.

502.3.1.11. Upperstem Thread Lubrication. Upperstem thread lubrication may be accomplished with oil or grease. When oil is used, it shall be in conjunction with a functional oil reservoir and an oil filler port. The hydrant shall be factory filled with a USP white mineral oil such as Lubriplate No. 3-V (SAE 20), Mobile Whiterex 425 or equal. Means for field check of oil lubrication level shall be provided. When grease is used, the hydrant shall be factory lubricated with a food grade grease such as Lubriplate No. 630-AA (medium soft), or equal. Means for field lubrication without disassembly shall be provided.

502.3.1.12. Tests and Affidavit of Compliance. Manufacturers shall be required to furnish the OWNER certificate of compliance with AWWA C502 and this specification.

Technical manufacturing drawings or certificate of tests relating to fire hydrants for contract installation must be supplied by the CONTRACTOR to OWNER not later than two weeks after beginning construction when identical hydrants have previously been approved by the OWNER, or prior to installation when identical hydrants have not previously been approved by the OWNER. Technical manufacturing drawings or certificate of tests must be supplied for all hydrants purchased by the OWNER. Technical drawings or certificates shall have the OWNER'S approval before final payment shall be made.

502.3.1.13. Sample Hydrant. The OWNER may purchase one sample hydrant for verification of compliance with these and manufacturer's specifications. The OWNER may test this sample; and, if it fails to meet any of the specifications, the hydrant shall be returned to CONTRACTOR at CONTRACTOR'S expense. CONTRACTOR shall refund to the OWNER the full purchase price of the hydrant.

502.3.1.14. Rejection. Fire hydrants or materials specified in this section may be rejected for failure to meet any of the provisions of this specification or for any defects causing them to be unsuitable for their intended use.

502.3.2. Installation. Fire hydrants shall be installed as shown in Standard Drawing 4120, on the appurtenance sheets or as directed by the OWNER.

Set fire hydrant on the lot line extended when possible. The horizontal center of the hydrant shall be placed not less than 3-feet and not more than 8-feet from the back of the nearest curb or edge of pavement no closer than 18-inches to existing or proposed sidewalks, and located at least 1-foot outside of the area between the Points of Curvature of the corner turning radii at intersections unless otherwise indicated on the plans.

The hydrant shall set truly vertical and be securely braced and blocked on well-compacted or undisturbed soil surrounded by a minimum of 7-CF clean gravel or stone to permit free draining of the hydrant, with the large pumper nozzle facing the nearest curb.

Fire hydrants shall be braced and blocked on a Class B or Class PB concrete per [Item 702](#). Concrete Structures, or as specified by the OWNER. Concrete slab shall not be less than 4-in thick and not less than 3ft. by 3-ft. square buried to a depth between 6- and 12-inches below finished grade. A splash pad that extends to the sidewalk, or to curb in the absence of a sidewalk, shall be installed if directed by the OWNER. Hydrant shall be set perpendicular with the pumper nozzle facing the nearest curb, and to a depth such that the center of the nozzle is between 18- and 28-inches from the top of finished grade.

Any adjustment needed after installation shall be made by the CONTRACTOR without extra compensation.

502.3.3. Measurement and Payment. Fire hydrants shall be measured per each, complete in place, as provided in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, material, tools, equipment, hydrant extensions, concrete, gravel drains, paint or protective coating and incidentals necessary to complete the work.

The hydrant lead shall be measured as installing pipe. The gate valve and box installed in leads shall be measured by the each.

Fire hydrant extensions shall be measured per foot if a separate pay item is established in the contract.

All payments for fire hydrants, hydrant lead, gate valve and box and fire hydrant extensions will be included in the contract costs and not be paid for separately

Refer to Standard Drawing 4120.

502.4. THRUST RESTRAINT

Each change in direction of a pressure conduit, fittings, and plugs in pressure conduits shall be restrained in such a manner as shall substantially brace the same against undisturbed trench walls. Type of thrust restraint shall be as specified on the plans.

502.4.1. Concrete Blocking. Standard thrust blocking shall conform to appropriate details and tables of Standard Drawings 4010A through 4040. Special blocking shall be accomplished with Class B or Class PB concrete per [Item 702](#), Concrete Structures, or as specified by the OWNER and as detailed on the appurtenance sheet or as detailed on the plans.

502.4.2. Mechanical Joint Restraint. Mechanical joint restraint may be used on ductile iron or PVC pipe. Installation shall follow manufacturer's recommendations.

Restraining mechanisms for PVC pipe and fittings shall be tested and pressure rated in accordance with ASTM F1674 Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

502.4.2.1. Ring and Wedging. Ring and wedging mechanical joint restraint shall be incorporated into the design of the follower gland. The restraint shall be sized and selected for material compatibility according to manufacturer's instructions. The restraining mechanism shall consist of individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be of grade 60-42-10 ductile iron conforming to ASTM A536 Ductile Iron Castings. The wedges shall be ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell conforming to AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings and AWWA C153 Ductile-Iron Compact Fittings for Water Service. Torque limiting twist-off nuts shall be used to insure proper actuation of the restraining wedges. Necessary spacers, gaskets and bolts shall be supplied by the manufacturer of ring and wedging restraint. Ring and wedging shall be coated as specified for pipe and fittings.

Restraint for nominal pipe sizes greater than 48-inches shall be engineered.

502.4.2.2. Integrally Restrained Mechanical Joints. In addition to specifications for Ductile Iron fittings in [Item 501.7](#), Ductile-Iron Pressure Pipe and Fittings or [Item 501.14](#), Polyvinyl Chloride (PVC) Water Pipe, integrally restrained mechanical joints shall conform to the applicable provisions of the standards listed in Table 502.4.2.2.(a) Integrally Restrained Mechanical Joint Standards.

Table 502.4.2.2.(a) Integrally Restrained Mechanical Joint Standards

Standard	Topic
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

502.4.3. Welding. Reinforced Concrete Cylinder Pipe (RCCP) may be internally or externally welded, as specified by the OWNER, according to manufacturer criteria in conformance with appropriate AWWA Standards.

502.4.4. Measurement and Payment. Payment will be included in the contract costs and not be paid for separately.

502.6. VALVES

502.6.1. Metal Seated Gate Valves for Ordinary Waterworks Service.

502.6.1.1. General Description. All gate valves 3-in. through 48-in. shall conform to AWWA Standards C500 Metal-Seated Gate Valves for Water Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard 61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Valves over 16-in. in diameter shall be installed in a special vault, as indicated in appropriate Division 4000 Standard Drawings, or the gear box shall be enclosed in a manhole and supported on a concrete pad. Smaller valves shall be supported with concrete, all as detailed in appurtenance sheets attached to the plans.

Gate valves larger than 48-in. shall be a special consideration. The OWNER shall hydrostatically test all gate valves larger than 48-in. for a reasonable period after receipt of a specified test pressure.

All gate valves shall be iron body, bronze mounted, double disc, parallel seat, nonrising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and tracks for gates.

502.6.1.2. Bonnet Bolting. Body bolts, studs and nuts shall be 304 stainless steel.

502.6.1.3. Ends. Valves shall have flanged, push-on, or mechanical-joint ends, or any combination of these as may be specified.

Mechanical-joint ends shall conform to AWWA C111 (ANSI A21.11) American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings. Push-on joint ends shall conform to AWWA C111 (ANSI A21.11). Flanged ends shall conform to AWWA C110 (ANSI A21.10) American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In. for Water and Other Liquids, Class 125-lb. Bolts and nuts for mechanical joints shall be of a high-strength, low-alloy corrosion-resistant steel conforming to ASTM A325 (A325M) High-Strength Bolts for Structural Steel Joints (Type 3). All mechanical-joint glands shall be ductile iron.

502.6.1.4. Gates and Rings. Gates and rings shall conform to AWWA Standards C500 except as follows: All gates above 4-in. shall be cast iron with bronze-gate rings, and 4-in. gates may be solid bronze. Gates 3-in. and smaller shall be solid bronze.

502.6.1.5. Wedging Device. Wedging devices shall conform to the requirements of AWWA C500, except as follows: Gate valves 4-in. and smaller shall have solid bronze wedges. Wedges for valves above 4-in. may be solid bronze or cast-iron with an integral bronze nut. Wedging surfaces may be bronze, monel, or stainless steel cast integral with the wedge. Stem nuts or wedging surfaces that are attached with fasteners are not acceptable. Wedging surfaces on valves up to 16-in. shall be bronze-, monel-, or stainless-steel- to- iron. Wedging surfaces on valves 16-in. and larger shall be bronze-to-bronze, monel-to-monel, or stainless-to- stainless. Other moving surfaces integral to the wedging action shall be bronze to iron.

502.6.1.6. Rollers and Tracks and Scrapers for Horizontal Valves. Rollers and tracks and scrapers for horizontal valves shall conform to AWWA Standards C500, with the following exception: Babbit tracks shall not be acceptable.

502.6.1.7. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C500, except as follows: Stem nuts shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as specified. Upset stems on valves larger than 16-in. shall not be permitted under these specifications. Upset stems shall conform to the requirements of AWWA C500.

502.6.1.8. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C500 with the following exceptions: All valves 2-in. through 16-in. shall be equipped with double Orings, provided arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double O-rings in the main stuffing box. All

horizontal valves shall have attached stuffing boxes as per the above AWWA Standards. Stuffing box bolts and nuts shall be 304 stainless steel.

502.6.1.9. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C500 with the following exceptions: Gland flanges or followers that are a separate part may be cast iron or bronze. Glands for valves over 12-in. in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.6.1.10. Hand Wheels and Operating Nuts. All valves 2-in. in diameter and above shall be nut operated unless otherwise ordered. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise or as specified by OWNER.

502.6.1.11. Gearing. Gearing shall be in accordance with AWWA C500. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. in diameter and larger.

502.6.1.12. Gear Cases. Gear cases shall be furnished on all geared valves. All geared valves shall be equipped with extended type gear cases, with cast iron side plates. Stuffing boxes shall be located on top of the bonnet and shall be outside the gear case. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole or vault. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be cast iron.

502.6.1.13. Bypass Valves. Bypass valves shall conform to the requirements of AWWA C500 with the following exceptions: Bypass valves are required on all 18-in. valves and larger AWWA C500 valves. Properties, construction and design requirements herein specified are applicable to bypass valves, except stems on bypass valves over 4-in. shall have the same physical qualities as for 30-in. and larger.

502.6.1.14. Cast Iron. All gray cast iron shall conform to the requirements of ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B or ductile iron shall conform to ASTM A536 Ductile Iron Castings.

502.6.1.15. Horizontal Valves. All valves over 16-in. in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.6.1.16. Valves for Installation in Vertical Pipeline. Valves 14-in. and larger AWWA C500 valves ordered for installation in vertical pipeline shall be equipped with disc face tracks and wedge springs to prevent pre-wedging. Valves 4-in. through 12-in. shall be double disc, square-bottom valves.

502.6.1.17. Tapping Valves. Tapping valves shall conform to the requirements of AWWA C500, and the other requirements of this section with the following exceptions: Tapping valves shall have oversize seat rings to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gates. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange recess to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

502.6.1.18. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

502.6.2. Resilient-Seated Gate Valves for Ordinary Waterworks Service.

502.6.2.1. General Description. All gate valves 3-in. through 36-in. shall conform to AWWA Standards C515 for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service, or C509 for Resilient-Seated Gate Valves for Water-Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard 61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 36-in. shall be a special consideration. The OWNER shall hydrostatically test all gate valves larger than 36-in. for a reasonable period after receipt.

All gate valves shall be iron body, resilient seated, nonrising bronze stem and bronze stem nut. Valves must have the resilient seat bonded and vulcanized to the wedge and employ the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and guide tracks for the gate.

502.6.2.2. Bonnet Bolting. Bonnet Bolting shall conform to [Item 502.6.1.2](#). Bonnet Bolting.

502.6.2.3. Ends. Ends shall conform to [Item 502.6.1.3](#). Ends.

502.6.2.4. Gate. Gate shall be encapsulated with an elastomer that meets all requirements of AWWA C515 or C509. The bonding of the rubber to the gate shall meet the requirements of ASTM D429, Test Method A or Method B. Gates 3-in. and smaller shall be rubber encapsulated bronze.

502.6.2.5. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C515 or C509 except as follows: Stem nuts shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as specified. Upset stems on valves larger than 16-in. shall not be permitted under these specifications.

502.6.2.6. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double o-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards.

502.6.2.7. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Gland flanges or followers, if used, that are a separate part may be cast iron or bronze. Glands for valves over 12-in. in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.6.2.8. Hand Wheels and Operating Nuts. Hand wheels and operating nuts shall conform to [Item 502.6.1.10](#).

502.6.2.9. Gearing. Gearing shall be in accordance with AWWA Standards C515 or C509. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. in diameter and larger.

502.6.2.10. Gear Cases. Gear cases shall be furnished on all geared valves. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole or vault. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be gray iron or ductile iron.

502.6.2.11. Bypass Valves. Bypass valves are not required on resilient seated gate valves.

502.6.2.12. Cast Iron. Cast iron shall conform to [Item 502.6.1.14](#).

502.6.2.13. Horizontal Valves. Valves for horizontal installation shall be equipped with wedge guide caps or inserts to guide and support the wedge during travel. All valves over 16-in. in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.6.2.14. Valves for Installation in Vertical Pipeline. All resilient seated gate valves shall be suitable for horizontal mounting in a vertical pipeline without special modifications.

502.6.2.15. Tapping Valves. Tapping valves shall conform to the requirements of AWWA Standards C515 or C509 and the other requirements of this section with the following exceptions: Tapping valves shall have a port opening to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gate. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

502.6.2.16. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA Standards C515 or C509. Any leaking at the test pressure through any casting shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

502.6.3. Air Valves.

502.6.3.1. General. Unless otherwise indicated in the plans or contract specifications, air valves shall meet the requirements of AWWA C512 Air Release, Air/Vacuum and Combination Air Valves for Water Works Service with exceptions specified herein. Only wastewater air valves shall be used for wastewater applications.

502.6.3.2. Description. Air valves shall be of two types as follows:

- (1) An air valve called for on the plans shall mean an air and vacuum valve of the ball type designed to permit the escape of air from a pipeline when the line is being filled and to permit air to enter the pipeline when the line is being emptied.
- (2) A combination air valve called for on the plans shall mean a combination air and vacuum and air release valve designed to fulfill the functions of air and vacuum valve and also designed to permit the escape of air accumulated in the line at the high point when the line is under pressure while in operation. Air valves 3-in. and smaller shall be self-contained in one unit. Air valves larger than 3in. may be a combination of two valves.

502.6.3.3. Material. The valves shall be stainless steel or iron body, stainless steel, brass or bronze fulcrum levers and links, stainless steel ball floats and pins, steel flange bolts and nuts, Buna-N synthetic rubber seats or equal against bronze or stainless steel, and brass for other parts.

502.6.3.4. Inlets and Outlets. Inlets shall be threaded for 2-in. and smaller and flanged for 3-in. and larger. Outlets shall be threaded through 4-in.

502.6.3.5. Operating Pressure and Testing. The valves shall be designed to operate under an operating pressure of 200-psi and shall be tested to 1½ times that pressure.

502.6.4. Brass Wheel Valves.

502.6.4.1. General. Valves furnished under this specification shall be wedge disc, non-rising stem gate valves with threaded ends. They shall be equipped with bronze hand wheels and nuts and shall have bronze packing gland followers. They shall be of all brass and/or bronze construction.

502.6.4.2. Pressure Rating. Valves shall be rated for 125-psi saturated steam working pressure and 200-psi for liquids and gases up to 150°F.

502.6.4.3. Tests. Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250-psi with the valve open. Under this test the valve shall not show any indication of leakage at the packing or anywhere on the body. Each valve shall also be tested at hydrostatic pressure of 250-psi applied to one end only with the valve closed. There shall be no indication of leakage by the gate or through the packing under this test.

502.6.4.4. Direction to Open. Valve shall open by turning the handwheel counterclockwise.

502.6.4.5. Material Specifications. The materials used in the manufacture of these valves shall equal or exceed the specifications shown in Table 502.6.4.5.(a) Brass Wheel Valve Materials.

Table 502.6.4.5.(a) Brass Wheel Valve Materials

Part	Material	Designation/Specification
Packing	Teflon impregnated asbestos or approved equal	
Body	Bronze	ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings
Bonnet	Bronze	ASTM B62
Gates	Bronze	ASTM B62
Handwheel	Bronze	ASTM B62
Handwheel Nut	Bronze	ASTM B62
Gland & Packing Nut	Lead-free Brass	ASTM B16/B16M Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
Stem	Bronze	ASTM B62, 50,000-psi minimum tensile strength

502.6.4.6. Stem. Stem shall be completely free of visible flaw, and matching shall be smooth and free of defect. A back seating surface shall be provided on the wedge or on the lifting nut to seat tightly against the bonnet when the valve is open to seal the packing gland against line pressure so that the valve may be repacked against line pressure.

502.6.4.7. Threaded Ends. Valve ends shall be threaded internally with American National Taper pipe threads. Thread shall be clean, smooth, true to form and concentric with the axis of the valve. Variations in alignment of thread shall not exceed $\frac{1}{16}$ -in.-per-foot. Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve at an angle approximately 45° with the axis of the thread for the purpose of easy entrance in making a joint and for protection of the thread.

502.6.4.8. Valve Body. The body of the valve shall offer sufficient support to the gate while it is moving to keep the gate wedge in place and to accurately align the gate on the body seat. The waterway opening shall be equal to or greater than the nominal pipe size.

502.6.4.9. Gate. The gate shall be of wedge design and may be furnished either solid or two-piece. Two-piece or "split" disc gates shall be equipped with lifting nut. Gate faces shall be accurately machined and fitted into the valve body in such a manner that the center of the gate circle is very slightly above the center of the seat circle when the valve is tightly closed.

502.6.4.10. Workmanship. All valve parts shall be true to form, free from injurious defects and shall be seated and finished in a workmanlike manner. Casting shall be free from blow holes, porosity, hard spots, excessive shrinkage, cracks or other injurious defects. They shall be smooth and well cleaned both inside and outside, and all fins and similar roughness shall be removed. Castings shall not be repaired, plugged, brazed or burned in.

502.6.4.11. Packaging. Valve shall be closed for shipment and wrapped or packaged in accordance with best commercial practice as necessary for mechanical protection and ease in handling.

502.6.5. Butterfly Valves.

502.6.5.1. General. Butterfly valves and actuators shall conform to AWWA C504 Rubber-Seated Butterfly Valves and to these specifications:

- (1) Type of body shall be short body, flanged.
- (2) Body material shall be cast iron or ductile iron.
- (3) Class shall be as specified on the plans or contract specifications.
- (4) Shafts shall be Type 304 or 316 stainless steel.
- (5) Flange holes shall be drilled full size.
- (6) Valve seats shall be natural rubber or Buna-N and polished stainless steel, Type 304 or 316, 90° seating angle only, with a 360° uninterrupted seating surface.
- (7) Shaft seals shall be standard split-V packing or double O-ring seal cartridges.
- (8) Discs shall be ductile iron, cast iron, or fabricated steel.
- (9) Operating nuts shall be ductile iron.

502.6.5.2. Submittals. The following shall be furnished to the OWNER. Incomplete data shall be cause for rejection of bid.

- (1) Weights and drawings in accordance with AWWA C504.
- (2) Guaranteed delivery time after receipt of purchase order.
- (3) Number of turns of handwheel required to close valve.
- (4) The required actuator torque (To) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
- (5) Seating-unseating torque (To) in foot-pounds required for each butterfly valve.
- (6) Rated torque capability of each butterfly valve actuator.
The following data shall be furnished if not previously available to the OWNER:
- (7) Experience: evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
- (8) Torque tests in accordance with rubber seated butterfly valves AWWA C504.
- (9) Proof of design tests in accordance with AWWA C504.

502.6.5.3. Ends. Valves shall have flanged ends. Flanged ends shall conform to AWWA C110 (ANSI A 21.10), Class 250-lb.

502.6.5.4. Actuators.**502.6.5.4.1. Manual Actuators.**

Location. All actuators shall be located at the right end of a horizontal shaft with the input shaft vertical and upward looking in the direction of flow, unless otherwise noted.

Closure. The valve shall close by turning the input shaft clockwise. All handwheels shall turn clockwise to close the valve. All operators shall be equipped with a disc position indicator with each valve. The indicator shall be highly visible, clearly showing the legends "Open" and "Closed" at the ends of a 90° arc, with a pointer to show the disc position (Closed — 0° and Open — 90°). The arc shall be graduated in degrees.

Type. All manual actuators shall be totally enclosed worm gear type and traveling-nut type. All manual worm gear type actuators shall be Limitorque, Type HBC or approved equal.

Sizing. Each valve actuator shall be sized for the maximum valve torque requirements based on the operating pressures and flow rates as specified.

502.6.5.4.2. Electric Motor Actuator. Each electric actuator shall conform to AWWA C504 and shall be of sufficient size to open and close the valve against maximum differential pressure and maximum required torque conditions when voltage at motor terminals is 90-percent of nominal voltage and shall have totally enclosed worm gear reducer with spur gear attached. Limit switches shall be of the four train gear with switches adjustable to operate at any point in the opening or closing cycle of the valve.

Limit switches and torque switches shall be located in a special compartment that is an integral part of the actuator and shall be readily accessible. Each limit switch shall have two normal closed contacts. Limit switch gearing shall be in step at all times whether in power or manual operation. Limit switch gearing shall be stainless steel or high-grade bronze. Two torque switches shall be furnished, one for opening direction and one for closing direction. The torque switches shall be connected in series so that they will operate regardless of the phasing of the power.

Torque and thrust loads in both closing and opening directions shall be limited by torque switches. Each torque switch shall be provided with a micrometer adjustment and reference setting indicator. The adjustment shall permit a variation of approximately 40-percent in torque setting. Switches shall have a rating of not less than 6-amperes at 120-volts-a.c. and 2.2-amperes at 115d.c. The torque switches shall be in series with the opening and closing coils of the starter.

The torque switches shall be factory adjusted by the manufacture for this application.

A handwheel for manual operation shall be provided. Motor shall not rotate when handwheel is in use. A fused motor shall not interfere with manual operation. For valve control, furnish for each valve a reversing starter in watertight enclosure that is integral with the actuator housing. Furnish a push-button station NEMA-4 with red and green indicating lights separate from the valve actuator. Space heaters shall be provided to protect the motor, reversing starter and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be furnished with submittal data.

Valve actuators shall conform to latest revision of AWWA C504 and shall be designed to hold the valve in any intermediate position between fully opened and fully closed without creeping and fluttering.

502.6.5.4.3. Other Actuators. Other types of actuators shall conform to AWWA C504.

502.6.5.5. Shipment and Storage Requirements. Electric motor actuated valves shall be shipped to bonded covered warehouse storage to be designated by the OWNER. Valves shall be stored indoors and shall have space heaters energized. Full face flange protectors of waterproof plywood shall be at least one-inch thick.

502.6.5.6. Tests. All butterfly valves shall be tested by the manufacturer in accordance with AWWA C504. Test results shall be furnished to the OWNER.

502.6.6. Line Valve Installation. At locations shown on the plans, CONTRACTOR shall furnish and install valves of the type and size indicated. Valve vaults shall be furnished as provided in the special contract documents and constructed in accordance with [Item 702.5.8.8](#). Vaults and applicable Division 4000 Standard Drawings.

502.6.6.1. Gate Valves. Valves shall be carefully handled and lowered into position in such a manner as to prevent damage to any part of the valve. The valve shall be placed in the proper position and held securely until all connections have been made. Where valves are to be placed in a concrete structure, the floor shall be completed before installing the valve. The valve shall be securely blocked so that its weight is carried by the floor rather than being supported by connected piping. See also Standard Drawing 4050.

502.6.6.2. Air Release Valves. The term "air release valve" as used in this section shall apply to the installation of both air release valve and combination air and vacuum release valves. Vaults shall be furnished as an integral part of either air release valve or combination air and vacuum release valve installation.

Air valves shall be installed in the manner shown in Standard Drawings 4090 – 4100B and on the appurtenance sheet unless otherwise indicated on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the schedule in Table 502.6.6.2.(a) Minimum Air Release Valve Sizing unless otherwise specified by the OWNER.

Table 502.6.6.2.(a) Minimum Air Release Valve Sizing¹

I.D. of Main (in.)	Size of Valve and Fitting (in.)
16 and smaller	1
18 through 36	2
42 and larger	3

1. This table is for use if no sizing is indicated on the plans.

Matching taps shall be provided for and made in accordance with [Item 502.10](#). Connections to Conduit for Service. Fittings required for mounting air valves shall be as specified in [Item 502.5](#). Fittings. All fittings shall be tight, leak free and plumbed true to the required position.

502.6.7. Rejection. Any valve may be rejected for failure to meet its respective requirements of this specification or referenced specifications.

502.6.8. Measurement and Payment. Where valves are furnished by the OWNER, the valves shall be measured for payment for handling, placing, installing, jointing, testing and all incidentals per each, grouped by size. Where the valves are to be furnished by the CONTRACTOR, the valves shall be measured for payment for furnishing, hauling, handling, placing, installing, jointing, testing and all incidentals per each, grouped by size. The price for valves shall include vault, roadway box, cover, extension pipe and pad supports since separate pay items shall not be set up for these items. Manholes or vaults for valve gear boxes shall be measured per each, grouped by sizes, complete in place, if provided in the proposal and contract. The contract unit price shall be the total compensation for labor, materials, tools, equipment and incidentals necessary to install valves complete in place in strict accordance with drawings, specifications, and/or instructions of the OWNER. Payment will be included in the contract costs and not be paid for separately.

504.5. EMBEDMENT

Embedment is the bedding and initial backfill. The type of embedment to be used for storm water collection systems, wastewater collection systems or water mains shall be specified in the contract documents or on the plans.

504.5.1. General**504.5.1.1. Terms.**

D — Inside diameter of the pipe.

OD — Outside diameter of the pipe.

B_c — Outside diameter of the pipe.

B_d — Trench width.

Stone cuttings are rock trench excavated material. The maximum allowable dimension of the stone to be used for embedment is 1-in.

Densities shall be shown as a percent of the maximum dry density at not less than 2% below optimum moisture of samples of the material as determined by the ASTM D698 Maximum Density Optimum Moisture Test.

504.5.1.2. Flexible Pipe. 16-in. or greater diameter flexible pipe may be strutted horizontally and vertically prior to backfilling. After backfilling, the struts shall be removed and the deflection checked to verify that excessive deflection as specified has not occurred. If excessive deflection has occurred, the pipe shall be removed and reinstalled.

504.5.1.3. Trench Dimensions. Trench dimensions shall be determined according to Table 504.5.1.3.(a) Trench Dimensions unless otherwise specified as greater.

Table 504.5.1.3.(a) Trench Dimensions

Pipe size	Trench Dimensions
Minimum Depth of Trench Below the Pipe	
27-in. and smaller	3-in.
30-in. to 60-in.	4-in.
66-in and larger	6-in.
Limiting Trench Width	
24-in. pipe and smaller	24-in. or O.D. of the pipe plus 16-in., whichever is greater
Greater than 24-in., to and including 72-in.	O.D. of the pipe installed plus 24-in.
Larger than 72-in.	O.D. times 1.25 plus 1-ft.

504.5.2. Embedment Classes.

504.5.2.1. Class “A” Embedment. See Standard Drawing 3010. The embedment consists of concrete bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the pipe shall be laid to grade on supporting brick or concrete block and jointed as specified. A compressible strip shall be placed between the pipe and the support. The pipe shall be restrained, if required, to prevent flotation. Class B or Class PB concrete as specified by the OWNER shall be poured on either side of the pipe to form the bedding under the pipe and up the sides of the pipe $\frac{1}{4}B_c$. The concrete placed under the pipe shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

The initial backfill layer shall be granular material and shall be brought to a point 12-in. above the top of the pipe.

504.5.2.2. Class “A-1” Embedment. See Standard Drawing 3010. The embedment consists of crushed stone bedding and a cap of concrete as initial backfill.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the bedding layer shall be brought to a point slightly above grade with compacted standard gradation crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe $\frac{1}{2}B_c$.

Class B or Class PB concrete as specified by the OWNER, plain or reinforced as specified in the plans, shall be poured over the top of the pipe and bells to cover the pipe with a thickness of $\frac{1}{4}B_c$, 4-in. minimum to form the initial backfill layer.

504.5.2.3. Class “B” Embedment. See Standard Drawing 3020. The embedment consists of crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above the grade with stone cuttings or crushed stone, standard gradation. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The crushed stone or stone cuttings shall then be brought up the sides of the pipe in uniform layers $\frac{1}{2}B_c$.

The initial backfill shall consist of granular material. The material shall be placed on top of the crushed stone in uniform layers on either side of the pipe to a point 12 in. above the top of the pipe and compacted to at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.4. Class “B+” Embedment. See Standard Drawing 3020. The embedment consists of fine crushed stone bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe $\frac{1}{2}B_c$.

The initial backfill shall consist of granular material. The material shall be placed on top of the stone and shall be brought up in uniform layers on either side of the pipe to a point 12-in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.5. Class “B-1” Embedment. See Standard Drawing 3020. The embedment consists of fine crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum 6 in. for measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed and the pipe laid and jointed as specified.

The stone shall then be brought up in uniform layers on either side of the pipe $\frac{3}{4}B_c$.

The initial backfill shall consist of compacted granular material brought up to a point 6 in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.6. Class “B-2” Embedment. See Standard Drawing 3030. The embedment consists of fine crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe 6 in. measured from the outside of the pipe bell, the bedding layer shall be brought to a point slightly above grade with compacted fine crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone bedding layer shall then be brought up in uniform layers on either side of the pipe $\frac{3}{4}B_c$.

The initial backfill shall consist of compacted granular material and shall be brought to a point 12 in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.7. Class “B-3” Embedment. See Standard Drawing 3030. The embedment consists of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of minimum of 6 in. measured from the outside of the pipe bell, the bedding shall be brought to a point slightly above grade with compacted fine sand. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The granular material shall then be brought up in uniform layers on either side of the pipe and over the pipe to a point 12 in. above the top of the pipe.

504.5.2.8. Class “B-4” Embedment. See Standard Drawing 3030. The embedment consists of cement-treated backfill.

After the trench has been cut to a depth below the barrel of the pipe a distance of minimum of 6 in. measured from the outside of the pipe bell, the bedding shall be brought to a point slightly above grade with cement-treated backfill. Bell holes shall be formed, if required, a trough scooped out to grade and the pipe laid and jointed as specified. The cement-treated backfill shall then be brought up to uniform layers on either side of the pipe and over the pipe to a point 6 in. above the top of the pipe.

504.5.2.9. Class “C” Embedment. See Standard Drawing 3040. The embedment is a bedding of crushed stone or stone cuttings and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with stone cuttings or standard crushed stone. Bell holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The initial backfill shall be granular material and shall be brought up in uniform compacted layers to a point 6 in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.10. Class “C+” Embedment. See Standard Drawing 3040. The embedment consists of fine crushed stone bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the bedding layer shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform, compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The initial backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6 in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.11. Class “C-1” Embedment. See Standard Drawing 3040. The embedment shall consist of fine sand bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$ minimum of 6 in. measured from the outside of the pipe bell, the bedding layer shall be brought up to a point slightly above grade with fine sand. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up in uniform compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The embedment backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6-in. above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.12. Class “D+” Embedment. See Standard Drawing 3050. The embedment consists of select material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 6 in. measured from the outside of the pipe bell, the embedment shall be brought up to a point slightly above grade with select material. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The material shall then be brought up in uniform

compacted layers to a point 6 in. over the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.13. Class “G” Embedment. See Standard Drawing 3050. The embedment consists of Class B or Class PB concrete as specified by the OWNER.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}B_c$, 6 in. minimum measured from the outside of the pipe bell, the pipe shall be laid and jointed as specified. The pipe shall be supported by brick or concrete block. A compressible strip shall be placed between the pipe and support. The pipe shall be restrained, if required, to prevent flotation. Class B or Class PB concrete as specified by the OWNER shall be poured on either side of the pipe to form the embedment under the pipe, up the sides and over the top of the pipe and bells with a minimum thickness of 6 in. The concrete placed under the bell shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

504.5.2.14. Class “G-1” Embedment. See Standard Drawing 3060. The embedment consists of Class “G” embedment as specified above and a trench backfill of Class B or Class PB concrete as specified by the OWNER or stabilized backfill, whichever is specified in the plans, and a 6 in. thick Class B or Class PB (as specified by the OWNER) concrete cap as initial backfill.

504.5.2.15. Class “H” Embedment. See Standard Drawing 3060. The embedment consists of a completely encased pipe with standard Crushed Stone, Grade 4. After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}B_c$, 6 in. minimum, the bedding layer shall be brought to a point slightly above grade with compacted crushed stone. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The material shall then be brought up in uniform compacted layers of 6 in. to a point 6 in. over the top of the pipe.

504.5.2.16. Alternate Embedment for Concrete Pipe. The Engineer may design alternate embedment for concrete pipe. Such embedment shall be designed according to Design Data 40, Standard Installations and Bedding Factors for the Indirect Design Method written by the American Concrete Pipe Association. Such embedment shall be constructed as shown on the plans.

504.5.3. Initial Backfill.

504.5.3.1. General. Initial backfill is the material that covers the storm drain system, wastewater collection system, and water lines. Backfill procedure is that procedure required to return trenches or excavated areas to a condition satisfactory to the OWNER. Such backfilling occurs in two general areas. They are: (1) areas not subject to vehicular traffic; and (2) areas subjected directly to, or influenced by, vehicular traffic.

The methods of backfilling to be used shall vary with the width of trench, the character of the materials excavated, the method of excavation, the type of conduit and the degree of compaction required. The placing of backfill shall not begin until the pipe structure has been properly bedded and jointed and until approval has been given by the OWNER. The excavation shall be backfilled only with approved material.

504.5.3.2. Compaction. Compaction of all backfill material shall be performed in a manner that shall not crack, crush and/or cause the installed pipe to be moved from the established grade and/or alignment, as shown on the plans. Satisfactory density shall be obtained at various depths on all backfill material as indicated from random selected test points prior to the required exfiltration or pressure tests that are to be performed on lines being constructed. The required moisture content shall be at not less than 2% below nor more than 4% above the optimum moisture of the material or as specified by the OWNER. In-place density/moisture content shall be tested and verified as specified by the OWNER, or at a minimum frequency of once per 300-linear-feet per 1-foot of compacted depth.

504.5.3.2.1. Densities — Areas Subjected To or Influenced by Vehicular Traffic. The trench backfill shall be mechanically compacted to the top of the subgrade in 6-in. loose lifts to at least 95percent of maximum density as determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³). The embedment shall be

compacted by a method approved by the OWNER to a density as specified under the description of the embedment as outlined in [Item 504.5](#). Embedment.

504.5.3.2.2. Densities — Areas Not Subjected To or Influenced by Vehicular Traffic. The trench backfill shall be placed in layers not more than 10-in. loose depth and shall be compacted by mechanical means, subject to the restrictions outlined in [Item 504.5.3.2.5](#). Compaction Methods to at least 90-percent of maximum density as determined by ASTM D698. The embedment shall be compacted by a method approved by the OWNER to a density as specified under the description of the embedment required as outlined in [Item 504.5](#). Embedment.

504.5.3.2.3. Special Situations. In areas specifically designated in the plans and specifications, the entire backfill shall be backfilled and compacted to the density specified.

504.5.3.2.4. Limitations. Densities as specified shall be obtained as the project progresses. No more than 75-percent of the pipe installation on the project is to be completed until specified compaction and density requirements have been ascertained on backfill material for at least 25-percent of the pipe laid, or until an approval to proceed with pipe installation has been given by the OWNER.

504.5.3.2.5. Compaction Methods. The method of compaction shall be left to the discretion of the CONTRACTOR with the following exception, unless otherwise specified, provided the degree of compaction is obtained and provided that the pipe is not damaged in the process. If any potential damage to the pipe due to a method of compaction exists, in the opinion of the OWNER, that method of compaction shall not be allowed.

Compaction of any backfill material by flooding or jetting shall not be permitted.

Hand-operated mechanical tampers may be used with approval of the OWNER for compacting backfill.

504.5.3.3. Rejection. If the backfill does not meet the specified density and optimum moisture requirements throughout its depth, the OWNER shall require its removal and replacement to meet the above requirements at the CONTRACTOR'S expense.

504.5.4 Measurement and Payment: Payment for embedment will be included in the contract costs and not be paid for separately. This includes all materials to be furnished, hauling, excavation, backfilling and all tools necessary to install embedment as shown on plans.

506.6. CONNECTIONS TO EXISTING WATER CONDUITS

Connection to an existing water conduit shall include not only branch connections but in-line connections for the purpose of making required pipe adjustments as well. Any connection or series of connections required to be performed on an existing water conduit shall meet with the OWNER'S specific approval as to the seasonal period when the work can be performed, the length of time required for the work to be completed, the work procedures proposed, and/or any other facet that could affect quality or quantity of water supply to the affected area. The work shall be performed with stringent built-in safeguards (such as adequate back-up equipment, labor and materials available) to ensure that time schedules are met without failure and subsequent set-back. Every effort shall be made to accomplish as much of the work as possible before actual tie-in is made into the existing conduit. This is especially applicable where vertical and horizontal concrete thrust blocks are a necessity to impose proper restraint of the pipe when the conduit is returned to full service. See Standard Drawings 4010A – 4040 for vertical and horizontal thrust blocks.

The CONTRACTOR shall notify the OWNER at least 48-hours in advance of a required valve shutdown.

Where indicated on the plans and/or herein specified, the CONTRACTOR shall connect the new conduit to existing conduits. The CONTRACTOR shall furnish all labor, materials, equipment and services required for the locating and uncovering of the existing line; the making of cuts in the existing line; the removal, relocation, and/or lowering of existing lines as required (See Standard Drawing 4200); dewatering of the trench; connecting of the existing lines to the new conduit; and all appurtenant work required for complete connection. Appurtenant work shall follow the requirements stated herein and as specified in [Item 502](#). Appurtenances. Relocated conduits or lines shall be laid so that all valves shall be set vertically. The CONTRACTOR shall be required to plug and block lines, crosses, tees or other fittings installed in the new conduit to permit hydrostatic testing and chlorination prior to making connections. Such plugs and blocking shall be adequate to withstand an applicable test pressure.

Where cut-ins are made immediately adjacent to valves which are under pressure, the CONTRACTOR shall take all necessary precautions to brace such valves with temporary blocking. Bracing shall be of ample size and properly placed to prevent movement or blowing off of any pipe, valves or fittings due to water pressure on the conduit.

Connections to existing water conduits shall be made at the locations shown, as specified, and/or as directed by the OWNER. All such connections shall be made in a most expeditious and workmanlike manner to cause the least inconvenience to water customers and to traffic. The detailed schedule of operations for making each connection shall be approved by the OWNER before any work thereupon is commenced.

In the case where blow-off connections or fire hydrants are not provided for flushing, the CONTRACTOR shall be required to leave one end of the new conduit open for flushing and then plug and block the end for chlorination and testing.

There shall be no separate pay items for taps, blow-offs for hydrostatic testing, disinfection purposes, and connections to existing water mains unless otherwise approved by the OWNER. Taps and blow-offs for hydrostatic testing and disinfection purposes shall be installed by the CONTRACTOR, at locations specified by the OWNER. This may include placing a blow-off on an existing conduit at the tie-in, or addition of a blow-off(s) at an isolated existing valve, for facilitation of hydrostatic testing and/or chlorination. Compression type curb stops are not permitted for blow-offs.

Upon completion of the hydrostatic testing and disinfection the CONTRACTOR shall return to the job site and remove the blow-off down to the corporation stop. CONTRACTOR shall leave the corporation stop and backfill, replacing all pavement. Removal of the blow-off shall include all labor, materials, tools, equipment, and incidentals necessary to complete the work, including excavation, disposal of surplus materials, and backfill with no separate pay item.

506.6.1. Water Main Tie-In During Off Hours. Tie-in connections affecting curtailment of quality or quantity of water to an area, businesses, etc., must be performed during the weekend or off-hours. All work must be coordinated through the OWNER or its representatives. Delay costs due to shut down and connection issues are considered incidental work and shall be borne by the CONTRACTOR. Payment will be included in the contract costs and not be paid for separately.

Item 506

Temporary Erosion, Sedimentation, and Environmental Controls



1. DESCRIPTION

Install, maintain, and remove erosion, sedimentation, and environmental control measures to prevent or reduce the discharge of pollutants in accordance with the Storm Water Pollution Prevention Plan (SWP3) on the plans and the Texas Pollutant Discharge Elimination System (TPDES) General Permit TXR150000. Control measures are defined as Best Management Practices used to prevent or reduce the discharge of pollutants. Control measures include, but are not limited to, rock filter dams, temporary pipe slope drains, temporary paved flumes, construction exits, earthwork for erosion control, pipe, construction perimeter fence, sandbags, temporary sediment control fence, biodegradable erosion control logs, vertical tracking, temporary or permanent seeding, and other measures. Erosion and sediment control devices must be selected from the *Erosion Control Approved Products* or *Sediment Control Approved Products* lists. Perform work in a manner to prevent degradation of receiving waters, facilitate project construction, and comply with applicable federal, state, and local regulations. Ensure the installation and maintenance of control measures is performed in accordance with the manufacturer's or designer's specifications.

Provide the Contractor Certification of Compliance before performing SWP3 or soil disturbing activities. By signing the Contractor Certification of Compliance, the Contractor certifies they have read and understand the requirements applicable to this project pertaining to the SWP3, the plans, and the TPDES General Permit TXR150000. The Contractor is responsible for any penalties associated with non-performance of installation or maintenance activities required for compliance. Ensure the most current version of the certificate is executed for this project.

2. MATERIALS

Furnish materials in accordance with the following:

- Item 161, "Compost,"
- Item 432, "Riprap," and
- Item 556, "Pipe Underdrains."

2.1. Rock Filter Dams.

2.1.1. Aggregate. Furnish aggregate with approved hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding. Provide the following:

- Types 1, 2, and 4 Rock Filter Dams. Use 3 to 6 in. aggregate.
- Type 3 Rock Filter Dams. Use 4 to 8 in. aggregate.

2.1.2. Wire. Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:

- a double-twisted, hexagonal weave with a nominal mesh opening of 2-1/2 × 3-1/4 in.;
- minimum 0.0866 in. steel wire for netting;
- minimum 0.1063 in. steel wire for selvages and corners; and
- minimum 0.0866 in. for binding or tie wire.

- 2.1.3. Sandbag Material. Furnish sandbags meeting Section 506.2.8., "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.
- 2.2. Temporary Pipe Slope Drains. Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections that conform to the plans. Recycled and other materials meeting these requirements are allowed if approved.

Furnish concrete in accordance with Item 432, "Riprap."
- 2.3. Temporary Paved Flumes. Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material that conforms to the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of 1/2 cu. ft. for the construction of energy dissipaters.
- 2.4. Construction Exits. Provide materials that meet the details shown on the plans and this Section.
 - 2.4.1. Rock Construction Exit. Provide crushed aggregate for long- and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials, and organic and injurious matter. Use 4- to 8-in. aggregate for Type 1. Use 2- to 4-in. aggregate for Type 3.
 - 2.4.2. Timber Construction Exit. Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers with nuts and bolts or lag bolts, of at least 1/2 in. diameter, unless otherwise shown on the plans or allowed. Provide plywood or pressed wafer board at least 1/2 in. thick for short-term exits.
 - 2.4.3. Foundation Course. Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.
- 2.5. Embankment for Erosion Control. Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.
- 2.6. Pipe. Provide pipe outlet material in accordance with Item 556, "Pipe Underdrains," and details shown on the plans.
- 2.7. Construction Perimeter Fence.
 - 2.7.1. Posts. Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in., or use nominal 2 × 4 in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/5 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
 - 2.7.2. Fence. Provide orange construction fencing as approved.
 - 2.7.3. Fence Wire. Provide 14 gauge or larger galvanized smooth or twisted wire. Provide 16 gauge or larger tie wire.
 - 2.7.4. Flagging. Provide brightly-colored flagging that is fade-resistant and at least 3/4 in. wide to provide maximum visibility both day and night.
 - 2.7.5. Staples. Provide staples with a crown at least 1/2 in. wide and legs at least 1/2 in. long.
 - 2.7.6. Used Materials. Previously used materials meeting the applicable requirements may be used if approved.

- 2.8. Sandbags. Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70%.

Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags. Filled sandbags must be 24 to 30 in. long, 16 to 18 in. wide, and 6 to 8 in. thick.

Table 1
Sand Gradation

Sieve Size	Retained (% by Weight)
#4	Maximum 3%
#100	Minimum 80%
#200	Minimum 95%

Aggregate may be used instead of sand for situations where sandbags are not adjacent to traffic. The aggregate size must not exceed 3/8 in.

- 2.9. Temporary Sediment Control Fence. Provide a net-reinforced fence using woven geo-textile fabric. Logos visible to the traveling public will not be allowed.
- 2.9.1. Fabric. Provide fabric materials in accordance with [DMS-6230](#), "Temporary Sediment Control Fence Fabric."
- 2.9.2. Posts. Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Furnish soft wood posts at least 3 in. in diameter, or use nominal 2 × 4 in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/2 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
- 2.9.3. Net Reinforcement. Provide net reinforcement of at least 12.5 gauge (SWG) galvanized welded wire mesh, with a maximum opening size of 2 × 4 in., at least 24 in. wide, unless otherwise shown on the plans.
- 2.9.4. Staples. Provide staples with a crown at least 3/4 in. wide and legs 1/2 in. long.
- 2.9.5. Used Materials. Use recycled material meeting the applicable requirements if approved.
- 2.10. Biodegradable Erosion Control Logs.
- 2.10.1. Core Material. Furnish core material that is biodegradable or recyclable. Use compost, mulch, aspen excelsior wood fibers, chipped site vegetation, agricultural rice or wheat straw, coconut fiber, 100% recyclable fibers, or any other acceptable material unless specifically called out on the plans. Permit no more than 5% of the material to escape from the containment mesh. Furnish compost meeting the requirements of Item 161, "Compost."
- 2.10.2. Containment Mesh. Furnish containment mesh that is 100% biodegradable, photodegradable, or recyclable such as burlap, twine, UV photodegradable plastic, polyester, or any other acceptable material.
- Furnish biodegradable or photodegradable containment mesh when log will remain in place as part of a vegetative system.
- Furnish recyclable containment mesh for temporary installations.
- 2.10.3. Size. Furnish biodegradable erosion control logs with diameters shown on the plans or as directed. Stuff containment mesh densely so logs do not deform.

3. QUALIFICATIONS, TRAINING, AND EMPLOYEE REQUIREMENTS

- 3.1. Contractor Responsible Person Environmental (CRPE) Qualifications and Responsibilities. Provide and designate in writing at the preconstruction conference a CRPE and alternate CRPE who have overall responsibility for the storm water management program. The CRPE will implement storm water and erosion control practices; will oversee and observe storm water control measure monitoring and management; will monitor the project site daily and produce daily monitoring reports as long as there are BMPs in place or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES General Permit TXR150000. During time suspensions when work is not occurring or on contract non-work days, daily inspections are not required unless a rain event has occurred. The CRPE will provide recommendations on how to improve the effectiveness of control measures. Attend the Department's preconstruction conference for the project. Ensure training is completed as identified in Section 506.3.3., "Training," by all applicable personnel before employees work on the project. Document and submit a list, signed by the CRPE, of all applicable Contractor and subcontractor employees who have completed the training. Include the employee's name, the training course name, and date the employee completed the training. Provide the most current list at the preconstruction conference or before SWP3 or soil disturbing activities. Update the list as needed and provide the updated list when updated.
- 3.2. Contractor Superintendent Qualifications and Responsibilities. Provide a superintendent that is competent, has experience with and knowledge of storm water management, and is knowledgeable of the requirements and the conditions of the TPDES General Permit TXR150000. The superintendent will manage and oversee the day to day operations and activities at the project site; work with the CRPE to provide effective storm water management at the project site; represent and act on behalf of the Contractor; and attend the Department's preconstruction conference for the project.
- 3.3. Training. All Contractor and subcontractor employees involved in soil disturbing activities, small or large structures, storm water control measures, and seeding activities must complete training as prescribed by the Department.

4. CONSTRUCTION

- 4.1. Contractor Responsibilities. Implement the SWP3 for the project site in accordance with the plans and specifications, TPDES General Permit TXR150000, and as directed. Coordinate storm water management with all other work on the project. Develop and implement an SWP3 for project-specific material supply plants within and outside of the Department's right of way in accordance with the specific or general storm water permit requirements. Prevent water pollution from storm water associated with construction activity from entering any surface water or private property on or adjacent to the project site.
- 4.2. Implementation. The CRPE, or alternate CRPE, must be accessible by phone and able to respond to project-related storm water management or other environmental emergencies 24 hr. per day.
- 4.2.1. Commencement. Implement the SWP3 as shown and as directed. Contractor-proposed recommendations for changes will be allowed as approved. Conform to the established guidelines in the TPDES General Permit TXR150000 to make changes. Do not implement changes until approval has been received and changes have been incorporated into the plans. Minor adjustments to meet field conditions are allowed and will be recorded in the SWP3.
- 4.2.2. Phasing. Implement control measures before the commencement of activities that result in soil disturbance. Phase and minimize the soil disturbance to the areas shown on the plans. Coordinate temporary control measures with permanent control measures and all other work activities on the project to assure economical, effective, safe, and continuous water pollution prevention. Provide control measures that are appropriate to the construction means, methods, and sequencing allowed by the Contract. Exercise precaution throughout the life of the project to prevent pollution of ground waters and surface waters. Schedule and perform clearing and grubbing operations so that stabilization measures will follow immediately thereafter if project conditions permit. Bring all grading sections to final grade as soon as possible and implement temporary and

permanent control measures at the earliest time possible. Implement temporary control measures when required by the TPDES General Permit TXR150000 or otherwise necessitated by project conditions.

Do not prolong final grading and shaping. Preserve vegetation where possible throughout the project, and minimize clearing, grubbing, and excavation within stream banks, bed, and approach sections.

4.3. General.

4.3.1. Temporary Alterations or Control Measure Removal. Altering or removal of control measures is allowed when control measures are restored within the same working day.

4.3.2. Stabilization. Initiate stabilization for disturbed areas no more than 14 days after the construction activities in that portion of the site have temporarily or permanently ceased. Establish a uniform vegetative cover or use another stabilization practice in accordance with the TPDES General Permit TXR150000.

4.3.3. Finished Work. Remove and dispose of all temporary control measures upon acceptance of vegetative cover or other stabilization practice unless otherwise directed. Complete soil disturbing activities and establish a uniform perennial vegetative cover. A project will not be considered for acceptance until a vegetative cover of 70% density of existing adjacent undisturbed areas is obtained or equivalent permanent stabilization is obtained in accordance with the TPDES General Permit TXR150000. An exception will be allowed in arid areas as defined in the TPDES General Permit TXR150000.

4.3.4. Restricted Activities and Required Precautions. Do not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens, or any other petroleum product. Operate and maintain equipment on-site to prevent actual or potential water pollution. Manage, control, and dispose of litter on-site such that no adverse impacts to water quality occur. Prevent dust from creating a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property. Wash out concrete trucks only as described in the TPDES General Permit TXR150000. Use appropriate controls to minimize the offsite transport of suspended sediments and other pollutants if it is necessary to pump or channel standing water (i.e., dewatering). Prevent discharges that would contribute to a violation of Edwards Aquifer Rules, water quality standards, the impairment of a listed water body, or other state or federal law.

4.4. Installation, Maintenance, and Removal Work. Perform work in accordance with the SWP3, according to manufacturers' guidelines, and in accordance with the TPDES General Permit TXR150000. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until soil disturbing activities are completed and permanent erosion control features are in place or the disturbed area has been adequately stabilized as approved.

The Department will inspect and document the condition of the control measures at the frequency shown on the plans and will provide the Construction SWP3 Field Inspection and Maintenance Reports to the Contractor. Make corrections as soon as possible before the next anticipated rain event or within 7 calendar days after being able to enter the worksite for each control measure. The only acceptable reason for not accomplishing the corrections with the time frame specified is when site conditions are "Too Wet to Work." Take immediate action if a correction is deemed critical as directed. When corrections are not made within the established time frame, all work will cease on the project and time charges will continue while the control measures are brought into compliance. Commence work once the Engineer reviews and documents the project is in compliance. Commencing work does not release the Contractor of the liability for noncompliance of the SWP3, plans, or TPDES General Permit TXR150000.

The Engineer may limit the disturbed area if the Contractor cannot control soil erosion and sedimentation resulting from the Contractor's operations. Implement additional controls as directed.

Remove devices upon approval or as directed. Finish-grade and dress the area upon removal. Stabilize disturbed areas in accordance with the permit, and as shown on the plans or directed. Materials removed are

considered consumed by the project. Retain ownership of stockpiled material and remove it from the project when new installations or replacements are no longer required.

- 4.4.1. Rock Filter Dams for Erosion Control. Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option.

Place the aggregate to the lines, height, and slopes specified, without undue voids for Types 1, 2, 3, and 5. Place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings for Types 2 and 3, or as directed. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams according to the following criteria unless otherwise shown on the plans:

- 4.4.1.1. Type 1 (Non-Reinforced).

- Height. At least 18 in. measured vertically from existing ground to top of filter dam.
- Top Width. At least 2 ft.
- Slopes. No steeper than 2:1.

- 4.4.1.2. Type 2 (Reinforced).

- Height. At least 18 in. measured vertically from existing ground to top of filter dam.
- Top Width. At least 2 ft.
- Slopes. No steeper than 2:1.

- 4.4.1.3. Type 3 (Reinforced).

- Height. At least 36 in. measured vertically from existing ground to top of filter dam.
- Top Width. At least 2 ft.
- Slopes. No steeper than 2:1.

- 4.4.1.4. Type 4 (Sack Gabions). Unfold sack gabions and smooth out kinks and bends. Connect the sides by lacing in a single loop–double loop pattern on 4- to 5-in. spacing for vertical filling. Pull the end lacing rod at one end until tight, wrap around the end, and twist 4 times. Fill with stone at the filling end, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires 4 times.

Place the sack flat in a filling trough, fill with stone, connect sides, and secure ends as described above for horizontal filling.

Lift and place without damaging the gabion. Shape sack gabions to existing contours.

- 4.4.1.5. Type 5. Provide rock filter dams as shown on the plans.

- 4.4.2. Temporary Pipe Slope Drains. Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced a maximum of 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete or rubble riprap in accordance with Item 432, "Riprap," when designated on the plans.

- 4.4.3. Temporary Paved Flumes. Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the

materials specified above, to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.

- 4.4.4. Construction Exits. Prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits when tracking conditions exist. Construct exits for either long- or short-term use.
 - 4.4.4.1. Long-Term. Place the exit over a foundation course as required. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.
 - 4.4.4.1.1. Type 1. Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.
 - 4.4.4.1.2. Type 2. Construct using railroad ties and timbers as shown on the plans or as directed.
 - 4.4.4.2. Short-Term.
 - 4.4.4.2.1. Type 3. Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.
 - 4.4.4.2.2. Type 4. Construct as shown on the plans or as directed.
- 4.4.5. Earthwork for Erosion Control. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
 - 4.4.5.1. Excavation and Embankment for Erosion Control Features. Place earth dikes, swales, or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed.

Create a sediment basin, where required, providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.
 - 4.4.5.2. Excavation of Sediment and Debris. Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.
- 4.4.6. Construction Perimeter Fence. Construct, align, and locate fencing as shown on the plans or as directed.
 - 4.4.6.1. Installation of Posts. Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8 to 10 ft.
 - 4.4.6.2. Wire Attachment. Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.
 - 4.4.6.3. Flag Attachment. Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.
- 4.4.7. Sandbags for Erosion Control. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags 1/2 the length of the preceding row. Place a single layer of sandbags downstream as a secondary

debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.

- 4.4.8. Temporary Sediment-Control Fence. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, as specified in this Section, or as directed.
- 4.4.8.1. Installation of Posts. Embed posts at least 18 in. deep, or adequately anchor, if in rock, with a spacing of 6 to 8 ft. and install on a slight angle toward the runoff source.
- 4.4.8.2. Fabric Anchoring. Dig trenches along the uphill side of the fence to anchor 6 to 8 in. of fabric. Provide a minimum trench cross-section of 6 × 6 in. Place the fabric against the side of the trench and align approximately 2 in. of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.
- 4.4.8.3. Fabric and Net Reinforcement Attachment. Attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced unless otherwise shown on the plans. Sewn vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 in. or less.
- 4.4.8.4. Fabric and Net Splices. Locate splices at a fence post with a minimum lap of 6 in. attached in at least 6 places equally spaced unless otherwise shown on the plans. Do not locate splices in concentrated flow areas.

Requirements for installation of used temporary sediment-control fence include the following:

- fabric with minimal or no visible signs of biodegradation (weak fibers),
- fabric without excessive patching (more than 1 patch every 15 to 20 ft.),
- posts without bends, and
- backing without holes.

- 4.4.9. Biodegradable Erosion Control Logs. Install biodegradable erosion control logs near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the biodegradable erosion control logs into the erosion measures used to control sediment in areas of higher flow. Install, align, and locate the biodegradable erosion control logs as specified below, as shown on the plans, or as directed.

Secure biodegradable erosion control logs in a method adequate to prevent displacement as a result of normal rain events, prevent damage to the logs, and as approved, such that flow is not allowed under the logs. Temporarily removing and replacing biodegradable erosion logs as to facilitate daily work is allowed at the Contractor's expense.

- 4.4.10. Vertical Tracking. Perform vertical tracking on slopes to temporarily stabilize soil. Provide equipment with a track undercarriage capable of producing a linear soil impression measuring a minimum of 12 in. long × 2 to 4 in. wide × 1/2 to 2 in. deep. Do not exceed 12 in. between track impressions. Install continuous linear track impressions where the 12 in. length impressions are perpendicular to the slope. Vertical tracking is required on projects where soil disturbing activities have occurred unless otherwise approved.
- 4.5. Monitoring and Documentation. Monitor the control measures on a daily basis as long as there are BMPs in place and/or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES General Permit TXR150000. During time suspensions when work is not occurring or contract non-work days, daily inspections are not required unless a rain event has occurred. Monitoring will consist of, but is not limited to, observing, inspecting, and documenting site locations with control measures and discharge points to provide maintenance and inspection of controls as described in the SWP3. Keep written records of daily monitoring. Document in the daily monitoring report the control measure condition, the date of inspection, required corrective actions, responsible person for making the corrections, and the date corrective actions were completed. Maintain records of all monitoring reports at the project site or at an approved place.

Provide copies within 7 days. Together, the CRPE and an Engineer's representative will complete the Construction Stage Gate Checklist on a periodic basis as directed.

5.	MEASUREMENT
5.1.	Rock Filter Dams. Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.
5.1.1.	Linear Measurement. When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.
5.1.2.	Volume Measurement. When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.
5.1.2.1.	Installation. Measurement will be made in final position.
5.1.2.2.	Removal. Measurement will be made at the point of removal.
5.2.	Temporary Pipe Slope Drains. Temporary pipe slope drains will be measured by the foot.
5.3.	Temporary Paved Flumes. Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.
5.4.	Construction Exits. Construction exits will be measured by the square yard of surface area.
5.5.	Earthwork for Erosion and Sediment Control.
5.5.1.	Equipment and Labor Measurement. Equipment and labor used will be measured by the actual number of hours the equipment is operated and the labor is engaged in the work.
5.5.2.	Volume Measurement.
5.5.2.1.	In Place.
5.5.2.1.1.	Excavation. Excavation will be measured by the cubic yard in its original position and the volume computed by the method of average end areas.
5.5.2.1.2.	Embankment. Embankment will be measured by the cubic yard in its final position by the method of average end areas. The volume of embankment will be determined between: ■ the original ground surfaces or the surface upon that the embankment is to be constructed for the feature and ■ the lines, grades and slopes of the accepted embankment for the feature.
5.5.2.2.	In Vehicles. Excavation and embankment quantities will be combined and paid for under "Earthwork (Erosion and Sediment Control, In Vehicle)." Excavation will be measured by the cubic yard in vehicles at the point of removal. Embankment will be measured by the cubic yard in vehicles measured at the point of delivery. Shrinkage or swelling factors will not be considered in determining the calculated quantities.
5.6.	Construction Perimeter Fence. Construction perimeter fence will be measured by the foot.
5.7.	Sandbags for Erosion Control. Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.

- 5.8. Temporary Sediment-Control Fence. Installation or removal of temporary sediment-control fence will be measured by the foot.
- 5.9. Biodegradable Erosion Control Logs. Installation or removal of biodegradable erosion control logs will be measured by the foot along the centerline of the top of the control logs.
- 5.10. Vertical Tracking. Vertical tracking will not be measured or paid for directly but is considered subsidiary to this Item.

6. PAYMENT

The following will not be paid for directly but are subsidiary to pertinent Items:

- erosion-control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter, unless a separate pay item is shown on the plans;
- repair to devices and features damaged by Contractor operations;
- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;
- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

Stabilization of disturbed areas will be subsidiary to pertinent Items.

Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly but is subsidiary to the excavation and embankment under this Item.

- 6.1. Rock Filter Dams. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately:

- 6.1.1. Installation. Installation of "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

- 6.1.2. Removal. Removal of "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made in accordance with Article 9.7, "Payment for Extra Work and Force Account Method" for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

- 6.2. Temporary Pipe Slope Drains. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Temporary Pipe Slope Drains" of the size specified. This price is full compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly but is subsidiary to the installation item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made in accordance with Article 9.7, "Payment for Extra Work and Force Account Method" for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be considered subsidiary to various bid items.

Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured in accordance with Item 432, "Riprap," and payment will be included in the contract costs and not be paid for separately.

- 6.3. Temporary Paved Flumes. The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made in accordance with Article 9.7, "Payment for Extra Work and Force Account Method" for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap, will be measured and payment will be included in the contract costs and not be paid for separately for under "Earthwork for Erosion and Sediment Control."

- 6.4. Construction Exits. Contractor-required construction exits from off right of way locations or on-right of way PSLs will not be paid for directly but are subsidiary to pertinent items.

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" for construction exits needed on right of way access to work areas required by the Department and payment will be included in the contract costs and not be paid for separately for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made in accordance with Article 9.7, "Payment for Extra Work and Force Account Method" for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be measured and payment will be included in the contract costs and not be paid for separately for under "Earthwork for Erosion and Sediment Control."

- 6.5. Earthwork for Erosion and Sediment Control.

- 6.5.1. Initial Earthwork for Erosion and Sediment Control. The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately bid for "Excavation (Erosion and Sediment Control, In Place)," "Embankment (Erosion and Sediment Control, In Place)," "Excavation (Erosion and Sediment

Control, In Vehicle),” “Embankment (Erosion and Sediment Control, (In Vehicle),” or “Earthwork (Erosion and Sediment Control, In Vehicle).”

This price is full compensation for excavation and embankment including hauling, disposal of material not used elsewhere on the project; embankments including furnishing material from approved sources and construction of erosion-control features; and equipment, labor, tools, and incidentals.

Sprinkling and rolling required by this Item will not be paid for directly but will be subsidiary to this Item.

- 6.5.2. Maintenance Earthwork for Erosion and Sediment Control for Cleaning and Restoring Control Measures. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid under a Contractor Force Account Item from invoice provided to the Engineer.

This price is full compensation for excavation, embankment, and re-grading including removal of accumulated sediment in various erosion control installations as directed, hauling, and disposal of material not used elsewhere on the project; excavation for construction of erosion-control features; embankments including furnishing material from approved sources and construction of erosion-control features; and equipment, labor, tools, and incidentals.

Earthwork needed to remove and obliterate erosion-control features will not be paid for directly but is subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly but will be subsidiary to this Item.

- 6.6. Construction Perimeter Fence. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” and payment will be included in the contract costs and not be paid for separately for “Construction Perimeter Fence.” This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for “Construction Perimeter Fence,” which is full compensation for the removal and reinstallation of the construction perimeter fence.

- 6.7. Sandbags for Erosion Control. Sandbags payment will be included in the contract costs and not be paid for separately for “Sandbags for Erosion Control” (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.

Removal of sandbags will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be in accordance with Article 9.7, “Payment for Extra Work and Force Account Method” for “Sandbags for Erosion Control,” which is full compensation for the reinstallation of the sandbags.

- 6.8. Temporary Sediment-Control Fence. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” and payment will be included in the contract costs and not be paid for separately as follows:

- 6.8.1. Installation. Installation of “Temporary Sediment-Control Fence (Install).” This price is full compensation for furnishing and operating equipment finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

- 6.8.2. Removal. Removal of "Temporary Sediment-Control Fence (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.9. Biodegradable Erosion Control Logs. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately as follows:
 - 6.9.1. Installation. Installation of "Biodegradable Erosion Control Logs (Install)" of the size specified. This price is full compensation for furnishing and operating equipment finish backfill and grading, staking, proper disposal, labor, materials, tools, and incidentals.
 - 6.9.2. Removal. Removal of "Biodegradable Erosion Control Logs (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.10. Vertical Tracking. Vertical tracking will not be measured or paid for directly but is considered subsidiary to this Item.

Item 529

Concrete Curb, Gutter, and Combined Curb and Gutter



1. DESCRIPTION

Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.

2. MATERIALS

Furnish materials conforming to:

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete or material specified on the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved.

When approved, use fibers meeting the requirements of [DMS-4550](#), "Fibers for Concrete," to replace reinforcing steel in Class A concrete. Dose fibers in accordance with the Department's MPL of pre-qualified fibers for concrete.

3. CONSTRUCTION

Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 420, "Concrete Substructures." Construct joints at locations shown on the plans. Cure for at least 72 hr.

Furnish and place reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans. Ensure that changes in curb grade and alignment do not exceed 1/4 in. between any 2 contacts on a 10-ft. straightedge.

- 3.1. Conventionally Formed Concrete. Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

Pour concrete into forms, and strike off with a template 1/4 to 3/8 in. less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.

Place curbs, gutters, and combined curb and gutters in 50-ft. maximum sections unless otherwise approved.

- 3.2. Extruded or Slipformed Concrete. Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. Coat cleaned surfaces, if required, with

approved adhesive or coating at the rate of application shown on the plans or as directed. Place concrete with approved self-propelled equipment.

The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

Attach a pointer or gauge to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved.

Finish surfaces immediately after extrusion or slipforming.

4. **MEASUREMENT**

This Item will be measured by the foot.

5. **PAYMENT**

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Concrete Curb," "Concrete Curb (Mono)," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of curb foundation, equipment, labor, materials, tools, and incidentals.

Item 531

Sidewalks



1. DESCRIPTION

Construct hydraulic cement concrete sidewalks.

2. MATERIALS

Furnish materials conforming to the following:

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete unless otherwise shown on the plans. Use Grade 8 course aggregate for extruded Class A concrete. Use other grades if approved.

3. CONSTRUCTION

Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Hand-tamp and sprinkle foundation when placement is directly on subgrade or foundation materials. Remove and dispose of existing concrete in accordance with Item 104, "Removing Concrete." Provide a clean surface for concrete placement directly on the surface material or pavement.

Mix and place concrete in accordance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Install joints as shown on the plans. Ensure that abrupt changes in sidewalk elevation do not exceed 1/4 in., sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope. Ensure that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans where a sidewalk crosses a concrete driveway.

Provide finished work with a well-compacted mass, a surface free from voids and honeycomb, and the required true-to-line shape and grade. Cure for at least 72 hr. in accordance with Item 420, "Concrete Substructures."

- 3.1. Conventionally Formed Concrete. Provide pre-molded or board expansion joints of the thickness shown on the plans for sidewalk section lengths greater than 8 ft. but less than 40 ft., unless otherwise directed. Terminate workday production at an expansion joint.
- 3.2. Extruded or Slipformed Concrete. Provide any additional surface finishing immediately after extrusion or slipforming as required on the plans. Construct joints at locations as shown on the plans or as directed.

4. MEASUREMENT

Sidewalks will be measured by the square yard of surface area. Curb ramps will be measured by the square yard of surface area or by each. A curb ramp consists of the ramp, landing, adjacent flares or side curb, and detectable warning surface as shown on the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Concrete Sidewalks" of the depth specified and "Curb Ramps" of the type specified. This price is full compensation for surface preparation of sidewalk foundation; materials; removal and disposal of existing concrete; excavation, hauling and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and connect to concrete driveways or turnouts will be measured and payment will be included in the contract costs and not be paid for separately in accordance with Item 530, "Intersections, Driveways, and Turnouts."

Item 644

Small Roadside Sign Assemblies



1.	DESCRIPTION ■ Installation. Furnish, fabricate, and erect small roadside sign assemblies or bridge mounted clearance sign assemblies consisting of the signs, sign supports, foundations (when required), and associated mounting hardware. ■ Relocation. Relocate existing small roadside sign assemblies or bridge mounted clearance sign assemblies, and furnish and fabricate material as required. ■ Removal. Remove existing small roadside sign assemblies or bridge mounted clearance sign assemblies.
2.	MATERIALS Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials that comply with the following Items and details shown on the plans: ■ Item 421, "Hydraulic Cement Concrete" ■ Item 440, "Reinforcement for Concrete" ■ Item 441, "Steel Structures" ■ Item 442, "Metal for Structures" ■ Item 445, "Galvanizing" ■ Item 636, "Signs" ■ Item 643, "Sign Identification Decals" ■ Item 656, "Foundations for Traffic Control Devices" Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for pipe, bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. When dissimilar metals are used, select or insulate metals to prevent corrosion.
3.	CONSTRUCTION Construct foundations in accordance with Item 656, "Foundations for Traffic Control Devices." Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult the appropriate utility company before beginning work. 3.1. Fabrication. Fabricate sign supports in accordance with Item 441, "Steel Structures." Ensure all components fit properly. Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans. Hot-dip galvanize fabricated parts in accordance with Item 445, "Galvanizing." Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged during assembly, transit, erection; or for any steel part or member welded, when permitted, after galvanizing. Perform all galvanizing repairs in accordance with Section 445.3.5., "Repairs."

- 3.2. Installation. Locate and install sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake sign support locations for verification by the Engineer.
- Install stub posts of the type, spacing, orientation, and projection shown on the plans. Remove and replace posts damaged during installation at the Contractor's expense.
- Connect the upper post sections to the stub post sections as shown on the plans. Torque connection bolts as shown on the plans.
- Attach signs to supports in accordance with the plans and pertinent Items.
- 3.3. Relocation. Reuse the existing signs as required unless otherwise shown on the plans. Furnish and install new stub posts in new foundations for relocated sign assemblies. Erect the new supports on the new stub posts, and attach the existing signs to the supports in accordance with the plans and pertinent Items. Remove existing foundations to be abandoned in accordance with Section 644.3.4., "Removal."
- 3.4. Removal. Remove abandoned concrete foundations to 2 ft. below finish grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.
- 3.5. Handling and Storage. Handle and store existing signs or portions of signs removed so they are not damaged. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.
- Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials, and dispose of them in accordance with federal, state, and local regulations.
- 3.6. Cleaning. Wash the entire sign after installation with a biodegradable cleaning solution acceptable to the sign face materials manufacturer to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

4. MEASUREMENT

This Item will be measured as each small roadside assembly or bridge mounted clearance sign assembly installed, removed, or relocated.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" and payment will be included in the contract costs and not be paid for separately for "Install Small Roadside Sign Assemblies" of the type specified, "Install Bridge Mounted Clearance Sign Assemblies" of the type specified, "Relocate Small Roadside Sign Assemblies" of the type specified, "Relocate Bridge Mounted Clearance Sign Assemblies" of the type specified, "Remove Small Roadside Sign Assemblies," or "Remove Bridge Mounted Clearance Sign Assemblies."

- 5.1. Installation. This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports; constructing foundations including concrete (when required); furnishing complete signs including sign connections and all hardware; attaching the signs to the supports; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.
- 5.2. Relocation. This price is full compensation for removing existing sign assemblies and related materials; furnishing and installing new stub posts and new sign supports; constructing foundations including concrete

(when required); and new hardware; reinstallation of signs; preparing and cleaning the signs; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

- 5.3. Removal. This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.



**GEOTECHNICAL ENGINEERING
SERVICES REPORT**

For the proposed

**John Kubala Water Treatment Lab and Maintenance
Building
7001 US 287 Frontage Road
Arlington, Texas**

Prepared for

**Jacobs
1999 Bryan Street, Suite 1200
Dallas, Texas 75201**

Prepared by

**Professional Service Industries, Inc.
310 Regal Row, Suite 500
Dallas, Texas 75247
Telephone (214) 330-9211**

PSI Project No. 03421705

March 29, 2019



2.0 SITE AND SUBSURFACE CONDITIONS

2.1 Site Location and Description

The project site is located at 7001 US 287 Frontage Road in Arlington, Texas. Based on visual observations at the time of drilling the site consisted of grass ground cover as well occasional trees. The site appeared to slope approximately 5 feet downward from southeast to northwest. The truck mounted drill rig experienced no difficulty in accessing the boring locations.

2.2 Field Exploration

Subsurface conditions at the site were explored by drilling seven borings at the approximate locations shown on the Boring Location Plan included in the Appendix. The borings were located in the field by PSI personnel using GPS coordinates obtained from Google Earth. The boring location information is included in Table 2.1.

Table 2.1: Boring Location Information

Boring Number	Boring Location	Depth (feet)	GPS Coordinates	
			Latitude	Longitude
B-1	Lab and Maintenance Building	25	32.63345	-97.17219
B-2	Lab and Maintenance Building	25	32.63309	-97.17217
B-3	Lab and Maintenance Building	25	32.63330	-97.17179
B-4	Lab and Maintenance Building	25	32.63340	-97.17150
B-5	Lab and Maintenance Building	25	32.63310	-97.17140
B-6	Pavement Area	6	32.63358	-97.17150
B-7	Pavement Area	6	32.63344	-97.17241

Note: GPS coordinates are based on hand-held GPS unit.

Elevations of the ground surface at the boring locations were not provided to PSI and should be determined by others prior to construction. Therefore, the references to depth of the various materials encountered are from the existing grade at the time of drilling.

The borings were drilled and sampled in general accordance with ASTM standards. Drilling equipment utilized for this project included truck-mounted rotary drilling equipment with appropriate support vehicles. The borings were drilled using continuous flight auger drilling techniques.

The borings were sampled continuously to the depth of 10 feet and at five-foot intervals thereafter. Soil formations were sampled using a three-inch outer-diameter seamless steel tube sampler (ASTM D 1587) and a two-inch outer-diameter split barrel sampler (ASTM D 1586). A hand penetrometer was used as an aid in evaluating the relative shear strength of the soils encountered during drilling. The hand penetrometer readings are shown on the boring logs at the corresponding sample depths.



Groundwater level measurements were recorded at boring locations during the field operations and were noted on the boring logs. The borings were backfilled with soil cuttings after the drilling operations were completed.

The subsurface conditions during drilling were monitored, logged and visually classified in the field by a geotechnical technician. Field notes were maintained for soil types and description, water levels, changes in subsurface conditions, and drilling conditions. After completion of field activities, the samples were transported to the laboratory in general accordance with ASTM D 4220. The soil samples were sealed in plastic bags and placed in secured containers prior to being transported to the geotechnical laboratory.

Boring logs, which include soil descriptions, water level information, laboratory test data, stratifications, classifications based on the ASTM D 2487 and D2488, and sample types and depths are included in the Appendix. A key to descriptive terms and symbols used on the boring logs is also presented in the Appendix.

2.3 Laboratory Testing

Laboratory testing of soils was performed in general accordance with applicable ASTM procedures. The laboratory testing program was established so that the engineering design parameters produced from the tests are appropriate for use in the engineering analyses and in support of the conclusions and recommendations.

The geotechnical laboratory testing included the following tests:

1. Classification (ASTM D 2487 / 2488)
2. Moisture Content (ASTM D 2216)
3. Atterberg Limits (ASTM D 4318)
4. Percent Soil Particles Finer than No. 200 Sieve (ASTM D 1140)
5. Unconfined Compression Test (ASTM D 2166)
6. Soluble Sulfate Ion Concentration Tests (TEX-145-E)

The samples not tested in the laboratory will be stored for a period of 60 days subsequent to submittal of this report and will be discarded after this period, unless other arrangements are made prior to the disposal period.

2.4 Site Geology

As shown on the Geologic Atlas of Texas, the site is located in an area where Cretaceous Age deposits of the Woodbine Formation (Kwb) are present at or near the ground surface. The Woodbine Formation (Kwb) in the project area generally consists of interbedded sands, cemented sands, clays, shales and sandstones. Dramatic variations in subsurface stratigraphy frequently occur over relatively short horizontal distances in the Woodbine Formation (Kwb). The subsurface conditions encountered in the borings are consistent with the mapped site geology.

2.5 Subsurface Conditions

The subsurface conditions identified at the boring locations are shown on the boring logs included in Appendix of this report. A key to terms and symbols used on the logs is also included in Appendix. Based on the subsurface conditions identified by the exploratory borings, the generalized subsurface profile



consists of interbedded medium dense to very dense, brown, tan, and gray Clayey Sand (SC) and stiff to hard, brown, tan, and gray Sandy Lean Clay (CL) overlying hard, gray, shaley Lean Clay (CL). At boring location B-1, hard, tan and gray, shaley Sandy Fat Clay (CH) was encountered.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratification, locations of the samples, and laboratory test data. The stratification shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected across the site. The stratification represents the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs.

2.6 Groundwater Information

The initial water levels were measured in the open boreholes during drilling and attempts were made to measure final water levels. Details of the groundwater conditions are summarized in Table 2.3.

Table 2.3: Groundwater Conditions

Boring Number	Boring Depth (feet)	Measured Groundwater Levels	
		During Drilling	At Completion
B-1	25	17 feet	14 feet
B-2	25	Not Encountered	Not Encountered
B-3	25	23 feet	Not Encountered
B-4	25	Not Encountered	Not Encountered
B-5	25	13 feet	10 feet
B-6	6	Not Encountered	Not Encountered
B-7	6	Not Encountered	Not Encountered

Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. Water seepage will largely depend on the permeability of the near surface soils. If more detailed water level information is required, observation wells or piezometers could be installed at the site, and water levels could be monitored.

The groundwater levels presented in this report are the levels that were observed at the time of the field activities. It is recommended that the contractor determine the actual groundwater levels at the site at the time of the construction activities to determine the impact, if any, on the construction procedures.

2.7 Sulfate Concentration Test Results and Discussion

The results of laboratory sulfate ion concentration tests (TEX-145-E) performed on soil samples obtained at boring locations are presented in Table 2.4.



Table 2.4: Sulfate Ion Concentration Test Results

Boring Number	Soil Classification	Depth (feet)	Sulfate Concentration (ppm)
B-6	Clayey Sand (SC), dense, brown and tan, with ferrous stains	0-2	120
B-7	Sandy Lean Clay (CL), very stiff to hard, brown, with occasional gravel	4-6	800

The concentration of water-soluble sulfates is a good indicator of the potential for chemical attack on concrete. Based on the ACI Manual of Concrete Practice (ACI 201.2R-10) or (ACI 318/318R-33), the amount of water-soluble sulfate in soil can be used to determine the sulfate exposure as shown in Table 2.5.

Table 2.5: Sulfate Exposure Rating

Water Soluble Sulfate in soil (percent by weight)	Sulfate Exposure
0.00 to 0.10	Negligible or Class 0 Exposure
0.10 to 0.20	Moderate or Class 1 Exposure
0.20 to 2.00	Severe or Class 2 Exposure
Over 2.0	Very Severe or Class 3 Exposure

Based on the test results shown in Table 2.5, the soils at this site could be considered as “Negligible or Class 0” sulfate exposure to concrete. However, as site grading is performed, sulfate seams may be randomly distributed across the site. It should be noted that limited testing alone might not provide a reliable indication.

In accordance with TxDOT publication, “Guidelines for Treatment of Sulfate-Rich Soils and Base in Pavement Structures”, the soils at this site are classified as “Level 1” soils because they have a sulfate content below 3,000 ppm. Based on limited testing alone, the soils encountered at this site are suitable for lime-treatment. However, further sulfate testing should be performed on bulk samples on-site prior to lime application to confirm the sulfate concentration of the soils exposed during mass grading.

APPENDIX



SITE VICINITY MAP



GEOTECHNICAL ENGINEERING SERVICES

JOHN KUBALA WATER TREATMENT LAB/MAINTENANCE BUILDING
7001 US 287 FRONTAGE ROAD
ARLINGTON, TEXAS

DATE: 03/29/2019

DRAWN: ZZ

CHKD:: KMV

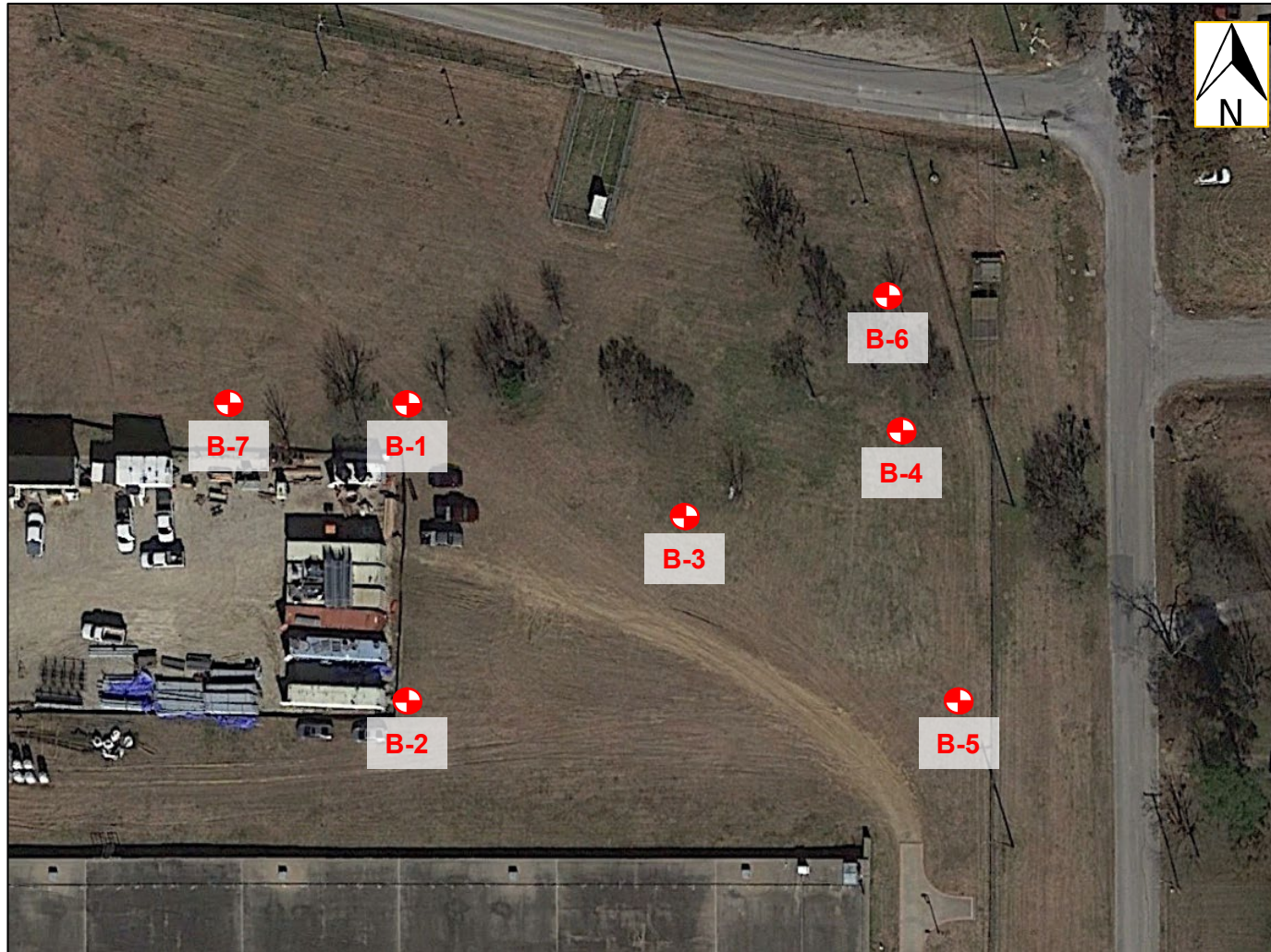
intertek
psi

**310 Regal Row, Suite 500
Dallas, Texas 75247
PHONE: (214) 330-9211**

FIGURE No. 1

PSI PROJECT No.: 03421705

BORING LOCATION PLAN - AERIAL



GEOTECHNICAL ENGINEERING SERVICES
JOHN KUBALA WATER TREATMENT LAB/MAINTENANCE BUILDING
7001 US 287 FRONTAGE ROAD
ARLINGTON, TEXAS

DATE: 03/29/2019

DRAWN: ZZ

CHKD:: KMV

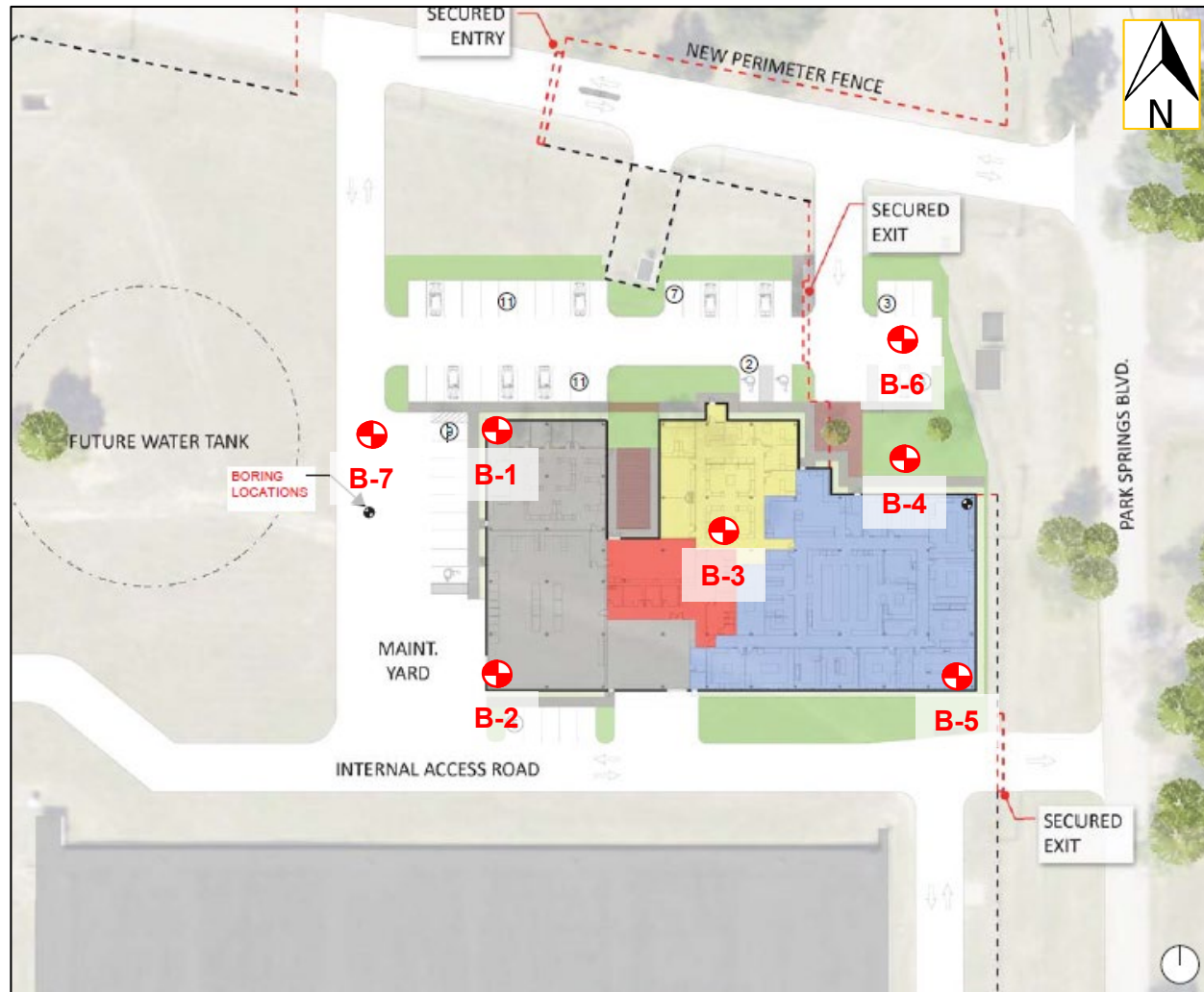


310 Regal Row, Suite 500
Dallas, Texas 75247
PHONE: (214) 330-9211

FIGURE No. 2

PSI PROJECT No.: 03421705

BORING LOCATION PLAN



GEOTECHNICAL ENGINEERING SERVICES
JOHN KUBALA WATER TREATMENT LAB/MAINTENANCE BUILDING
7001 US 287 FRONTAGE ROAD
ARLINGTON, TEXAS

DATE: 03/29/2019

DRAWN: ZZ

CHKD:: KMV



310 Regal Row, Suite 500
Dallas, Texas 75247
PHONE: (214) 330-9211

FIGURE No. 3

PSI PROJECT No.: 03421705

LOG OF BORING B-1

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.63345 LONGITUDE: -97.17219	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.						UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
			○ HP ● UC ▲ UU														
			0						1	2	3	4	5				
0			DESCRIPTION		11												
CLAYEY SAND (SC), medium dense, brown, with occasional gravel				19	37	23	14										
SANDY LEAN CLAY (CL), very stiff to hard, tan and gray, with ferrous seams				16													
				18													
SANDY FAT CLAY (CH), hard, tan and gray, shaley, with ferrous seams				20	53	19	34										
				21													
CLAYEY SAND (SC), very dense, light brown and gray			N:50(3.5")	23													
LEAN CLAY (CL), hard, gray, shaley, with occasional sand seams			N:50(5.0")	15													
30																	
35																	
40																	
45																	

DEPTH OF BORING: 25 FEET

DATE DRILLED: 3/20/19

NOTES: Automatic hammer, 170 lbs, 24-inch drop

DEPTH TO GROUND WATER

GROUND WATER DURING DRILLING: 17 feet

GROUND WATER AFTER DRILLING: 14 feet

DELAYED GROUND WATER: N/A

BL DALLAS - PSIHOUSTON.GDT - 3/29/19 16:03 - \\DALLAS-FS\PROJECTS\03421705 GEO\2019 JOHN KUBALA WATER TREATMENT LAB, ARLINGTON, TX- JACOBS\APPENDIX\03421705.GPJ

LOG OF BORING B-2

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.63309 LONGITUDE: -97.17217	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.	UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
			DESCRIPTION			LL	PL	PI				
0			CLAYEY SAND (SC) , dense, brown and tan, with clay seams and ferrous stains		12	30	13	17				49
5			LEAN CLAY (CL) , hard, tan and gray, with ferrous deposits		17							
					16	39	13	26		112	0.79	99
10					19							
15			SANDY LEAN CLAY (CL) , very stiff to hard, tan and gray, shaley, with ferrous deposits		23					106	1.81	
20			-sand seam 18-20 feet		25							
25			LEAN CLAY (CL) , very stiff, gray, shaley		17							
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 FEET

DATE DRILLED: 3/20/19

NOTES: Automatic hammer, 170 lbs, 24-inch drop

DEPTH TO GROUND WATER

GROUND WATER DURING DRILLING: NOT ENCOUNTERED

GROUND WATER AFTER DRILLING: DRY

DELAYED GROUND WATER: N/A

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LOG OF BORING B-3

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.6333 LONGITUDE: -97.17179	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.	UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
			DESCRIPTION			LL	PL	PI	○ HP ● UC ▲ UU			
0			CLAYEY SAND (SC), medium dense, brown, with clay seams		13				○ HP ● UC ▲ UU			
5			SANDY LEAN CLAY (CL), very stiff to hard, tan and gray, with occasional sand seams		15	41	17	24	○ HP ● UC ▲ UU	112	1.76	50
10					15				○ HP ● UC ▲ UU			
15			SANDY LEAN CLAY (CL), hard, tan and gray, shaley, with occasional sand seams		24				○ HP ● UC ▲ UU			
20			LEAN CLAY (CL), hard, gray, shaley, with occasional sand seams		20				○ HP ● UC ▲ UU			
25			N:50(5.5") 19		19				○ HP ● UC ▲ UU			88

DEPTH OF BORING: 25 FEET

DATE DRILLED: 3/20/19

NOTES: Automatic hammer, 170 lbs, 24-inch drop

DEPTH TO GROUND WATER

GROUND WATER DURING DRILLING: 23 feet

GROUND WATER AFTER DRILLING: NOT ENCOUNTERED

DELAYED GROUND WATER: N/A

LOG OF BORING B-4

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.63340 LONGITUDE: -97.17150	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.	UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
			DESCRIPTION			LL	PL	PI				
0			CLAYEY SAND (SC), dense, reddish tan		15	30	14	16				38
			SANDY LEAN CLAY (CL), very stiff, brown, tan, and gray, with sand seams		15							
5					16							
					16							
10			SILTY, CLAYEY SAND (SC-SM), brown and tan, with clay seams	N: 15	5	20	13	7				44
15			SANDY LEAN CLAY (CL), hard, tan and gray, with reddish brown sand seams		19							
20			SANDY LEAN CLAY (CL), hard, tan and gray, shaley, with sand seams		15							
25					25							
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 FEET

DATE DRILLED: 3/20/19

NOTES: Automatic hammer, 170 lbs, 24-inch drop

DEPTH TO GROUND WATER

GROUND WATER DURING DRILLING: NOT ENCOUNTERED

GROUND WATER AFTER DRILLING: DRY

DELAYED GROUND WATER: N/A

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LOG OF BORING B-5

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.6331 LONGITUDE: -97.1714	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.	UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
			DESCRIPTION			LL	PL	PI				
0			SANDY LEAN CLAY (CL) , hard, brown, with occasional gravel		13							
			CLAYEY SAND (SC) , medium dense, dark brown	N: 14	10							34
5			SANDY LEAN CLAY (CL) , hard, tan and gray		13							
					14	32	13	19				56
10					14							
			-gravelly sand seam at 13 feet		18							
15												
20			LEAN CLAY (CL) , hard, gray, shaley		17							
25				N: 52	16							
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 FEET

DATE DRILLED: 3/20/19

NOTES: Automatic hammer, 170 lbs, 24-inch drop

DEPTH TO GROUND WATER

GROUND WATER DURING DRILLING: 13 feet

GROUND WATER AFTER DRILLING: 10 feet

DELAYED GROUND WATER: N/A

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LOG OF BORING B-6

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.63358 LONGITUDE: -97.1715	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.	UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE
0			DESCRIPTION									
0			CLAYEY SAND (SC), dense, brown and tan, with ferrous stains		11							
1					12							
5					13	28	11	17				47
10												
15												
20												
25												
30												
35												
40												
45												
50												

DEPTH OF BORING: 6 FEET
DATE DRILLED: 3/20/19

DEPTH TO GROUND WATER
GROUND WATER DURING DRILLING: NOT ENCOUNTERED
GROUND WATER AFTER DRILLING: DRY
DELAYED GROUND WATER: N/A

NOTES: Automatic hammer, 170 lbs, 24-inch drop

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LOG OF BORING B-7

John Kubala Water Treatment Lab and Maintenance Building
7001 US 287 Frontage Road, Arlington, Texas

TYPE OF BORING: SOLID FLIGHT AUGER
LOCATION: SEE BORING LOCATION PLAN

PSI Project No.: 03421705

DEPTH, FT.	SOIL TYPE	SAMPLES	COORDINATE (X) OR EASTING: COORDINATE (Y) OR NORTHING: APPROX. SURFACE ELEVATION: LATITUDE: 32.63344 LONGITUDE: -97.17241	SPT - N TCP - T (BLOWS/FT.)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	COMPRESSION STRENGTH TONS/SQ.FT.			UNIT DRY WT. (PCF)	COMPRESSION STRENGTH (tsf)	% PASSING #200 SIEVE			
									HP	UC	UU						
0			DESCRIPTION			LL	PL	PI	0	1	2	3	4	5			
			SANDY LEAN CLAY (CL) , very stiff to hard, brown, with occasional gravel		11	27	11	16									64
					16										114	1.79	
5					17												
10																	
15																	
20																	
25																	
30																	
35																	
40																	
45																	
50																	

DEPTH OF BORING: 6 FEET
DATE DRILLED: 3/20/19

DEPTH TO GROUND WATER
GROUND WATER DURING DRILLING: NOT ENCOUNTERED
GROUND WATER AFTER DRILLING: DRY
DELAYED GROUND WATER: N/A

NOTES: Automatic hammer, 170 lbs, 24-inch drop

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KEY TO TERMS AND SYMBOLS USED ON LOGS

ROCK CLASSIFICATION

RECOVERY

DESCRIPTION OF RECOVERY	% CORE RECOVERY
Incompetent	< 40
Competent	40 TO 70
Fairly Continuous	70 TO 90
Continuous	90 TO 100

ROCK QUALITY DESIGNATION (RQD)

DESCRIPTION OF ROCK QUALITY	RQD
Very Poor (VPo)	0 TO 25
Poor (Po)	25 TO 50
Fair (F)	50 TO 75
Good (Gd)	75 TO 90
Excellent (ExInt)	90 TO 100

CONSISTENCY OF ROCK CORES

CONSISTENCY	UNCONF. COMP. STRENGTH IN TSF
Very Soft	10 TO 250
Soft	250 TO 500
Hard	500 TO 1000
Very Hard	1000 TO 2000
Extra Hard	>2000

SOIL DENSITY OR CONSISTENCY

DENSITY (GRANULAR)	CONSISTENCY (COHESIVE)	THD (BLOWS/FT)	FIELD IDENTIFICATION
Very Loose (VLo)	Very Soft (VSo)	0 TO 8	Core (height twice diameter) sags under own weight
Loose (Lo)	Soft (So)	8 TO 20	Core can be pinched or imprinted easily with finger
Slightly Compact (SlCmpt)	Stiff (St)	20 TO 40	Core can be imprinted with considerable pressure
Compact (Cmpt)	Very Stiff (VSt)	40 TO 80	Core can only be imprinted slightly with fingers
Dense (De)	Hard (H)	80 TO 5"/100	Core cannot be imprinted with fingers but can be penetrated with pencil
Very Dense (VDe)	Very Hard (VH)	5"/100 to 0"/100	Core cannot be penetrated with pencil

BEDROCK HARDNESS

MORHS' SCALE	CHARACTERISTICS	EXAMPLES	APPROXIMATE THD PEN TEST	
5.5 to 10	Rock will scratch knife	Sandstone, Chert, Schist, Granite, Gneiss, some Limestone	Very Hard (VH)	0" to 2"/100
3 to 5.5	Rock can be scratched with knife blade	Siltstone, Shale, Iron Deposits, most Limestone	Hard (H)	1" to 5"/100
1 to 3	Rock can be scratched with fingernail	Gypsum, Calcite, Evaporites, Chalk, some Shale	Soft (So)	4" to 6"/100

RELATIVE DENSITY FOR GRANULAR SOILS

APPARENT DENSITY	SPT (BLOWS/FT)	CALIFORNIA SAMPLER (BLOWS/FT)	MODIFIED CA. SAMPLER (BLOWS/FT)	RELATIVE DENSITY (%)
Very Loose	0 to 4	0 to 5	0 to 4	0 to 15
Loose	4 to 10	5 to 15	5 to 12	15 to 35
Medium Dense	10 to 30	15 to 40	12 to 35	35 to 65
Dense	30 to 50	40 to 70	35 to 60	65 to 85
Very Dense	>50	>70	>60	85 to 100

ABBREVIATIONS

PL – Plastic Limit
LL – Liquid Limit
WC – Percent Moisture
Q_p – Hand Penetrometer
Q_u – Unconfined Compression Test
UU – Unconsolidated Undrained Triaxial

Note: Plot Indicates Compressive Strength as Obtained By Above Tests

▽ INITIAL GROUND WATER

▽ FINAL GROUND WATER

U.S. STANDARD SIEVE SIZE(S)

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	2.0	0.42	0.074		0.002

GRAIN SIZE IN MM

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	N-VALUE (Blows/Foot)	SHEAR STRENGTH (tsf)	HAND PEN VALUE (tsf)
Very Soft	0 TO 2	0 TO 0.125	0 TO 0.25
Soft	2 TO 4	0.125 TO 0.25	0.25 TO 0.5
Firm	4 TO 8	0.25 TO 0.5	0.5 TO 1.0
Stiff	8 TO 15	0.5 TO 1.0	1.0 TO 2.0
Very Stiff	15 TO 30	1.0 TO 2.0	2.0 TO 4.0
Hard	>30	>2.0 OR 2.0+	>4.0 OR 4.0+

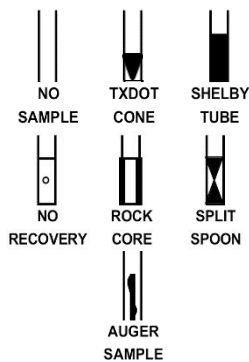
DEGREE OF PLASTICITY OF COHESIVE SOILS

DEGREE OF PLASTICITY	PLASTICITY INDEX (PI)	SWELL POTENTIAL
None or Slight	0 to 4	None
Low	4 to 20	Low
Medium	20 to 30	Medium
High	30 to 40	High
Very High	>40	Very High

MOISTURE CONDITION OF COHESIVE SOILS

DESCRIPTION	CONDITION
Absence of moisture, dusty, dry to touch	DRY
Damp but no visible water	MOIST
Visible free water	WET

SAMPLER TYPES



SOIL TYPES

