

CITY OF GEORGETOWN, TEXAS



CONTRACT DOCUMENTS AND TECHNICAL SPECIFICATIONS
FOR THE CONSTRUCTION OF

VOLUME 1 OF 2

San Gabriel WWTP Rehabilitation

PROJECT No. PRJ000165

JANUARY 2023

RFP No. 202305

Contract No. 23-0041-CIP

**CONFORMED CONSTRUCTION SET
MAY 2023**



TBPE FIRM REGISTRATION NO. F-3043

9430 Research Blvd., Suite 1-200
Austin, Texas 78759
tel 512-346-1100
fax 512-345-1483


CDM Smith Project No. 2048-264953

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CERTIFICATIONS

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Division CIP	(All Sections)
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Alexandra T. Doody



January 27, 2023

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Division 31	(All Sections)



Aravind Pedarla
01/27/2023

Division 3	(All Sections)
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Chun For Wong
01-27-2023

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Division 22 (All Sections)
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Juan Carlos Saenz



01/27/2023

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San Gabriel WWTP Rehabilitation

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CONSTRUCTION SERVICES
for
San Gabriel WWTP Rehabilitation
RFP 202305
Due: April 20, 2023, 2PM

REQUEST FOR PROPOSAL
SERVICES

CITY OF GEORGETOWN
510 W. 9th Street
Georgetown, TX 78626

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INTRODUCTION

The City of Georgetown is seeking proposals from all qualified respondents to perform construction services of the San Gabriel WWTP Rehabilitation located at 1107 N. College St., Georgetown, TX.

The successful Offeror (Consultant) must meet all requirements of this RFP, maintain proper licensing, and comply with all federal, state, and local laws and mandates relative to the services specified in this RFP.

DEFINITIONS

The following definitions shall be used to identify terms throughout this Request for Proposals:

A. AGREEMENT

A mutually binding legal document obligating the Consultant to furnish the services specified within this solicitation and obligating the City to pay for the services as agreed upon.

B. CITY

The City of Georgetown, located in Williamson County, Texas.

C. CITY COUNCIL

The elected officials of the City of Georgetown, Texas, given the authority to exercise such powers and jurisdiction of all City business as conferred by the City Charter and State Constitution and Laws.

D. CONSULTANT

Person or business enterprise providing goods or services to the City as fulfillment of obligations arising from an agreement pursuant to this Request for Proposals. The successful Offeror of this Request for Proposals.

E. E-BID SYSTEM

The City's electronic bidding system. This is a web-based system that provides all solicitation documents electronically to potential Offerors and allows interested Offerors to submit Proposals in response to solicitation documents. The term "e-bid" and/or "electronic bid" means the Offeror's electronic Proposal submitted to the City by way of the E-bid system. The terms "electronic bid" or "e-bid" are used interchangeably to describe the above invitation for proposal process to submit an authorized Proposal to the City in response to this Request for Proposals.

F. OFFEROR

The **Individual, Firm or Corporation (Offeror)** that considers themselves qualified to provide the services specified herein and are interested in making an offer to provide the goods to the City.

G. PIGGYBACK CONTRACT

A contract or agreement that has been competitively solicited in accordance with State of Texas statutes, rules, policies and procedures and has been extended for the use of state and local agencies that have entered (or will) into an Interlocal Agreement with the City.

H. PROPOSAL

A complete, properly signed response to this solicitation.

I. PURCHASE ORDER

A purchase order records the financial obligation of the City to pay for goods or services properly received; therefore, a purchase order is also required for all contracts with an expenditure of funds entered into by the City Manager or City Council.

J. REQUEST FOR PROPOSALS (RFP)

This solicitation document issued by the City containing terms, conditions and specifications for the services to be procured.

NOTICE TO OFFERORS

A. NOTICE

All Proposals are due on or before **2:00 PM CST on April 20, 2023** Solicitations are posted and available to download from the City of Georgetown's On-Line Bidding System at <https://gtowntx.ionwave.net>.

Offerors may receive notice of Requests for Proposals from the City of Georgetown from a variety of channels. Approved methods of dissemination include: City of Georgetown website or the City of Georgetown Purchasing Office. The receipt of solicitations through any other means may result in the receipt of incomplete specifications or addenda which could ultimately render your Proposal non-compliant. City of Georgetown accepts no responsibility for the receipt or notification of solicitations through any other source.

B. RECEIPT OF PROPOSALS

1. Electronic Proposals. Sealed Electronic Proposals shall be submitted through the City's web site at: <https://georgetown.ionwave.net>. All interested Offerors are required to register as a "supplier" on the City's E-bid System at the above web address and clicking on "Supplier Registration." Registration provides automatic access to the solicitation and its documents (specifications, attachments, exhibits), and for any changes to the solicitation including change(s) to the submission time and date.

Electronic Proposals must be received prior to the time and date specified in the City's E-bid System. The mere fact that the Proposal was dispatched will not be considered; the Offeror must ensure that the Proposal was properly uploaded in the System. The time Proposals are received shall be determined by the electronic clock in the City's E-bid System.

C. QUESTIONS and INQUIRIES

Questions and inquiries about this Request for Proposals shall be submitted in writing to the following individual:

Donna Cantwell
Purchasing Department
Email: donna.cantwell@georgetown.org

D. The deadline for written questions is **April 13, 2023 at @ 5:00PM (CST)**. This deadline has been established in order to provide adequate time for City staff to prepare responses to questions from Offerors to the best of their ability in advance of the Pre-Proposal Conference meeting.

E. Offerors shall not attempt to contact City Council members, City staff or Management directly during the pre-proposal or post-proposal period. The City intends to respond to all appropriate questions or concerns; however, the City reserves the right to decline to respond to any question or concern. All material modifications, clarifications or interpretations will be incorporated into an addendum which will be publicly posted. All addenda issued prior to the due date and time for responses are incorporated into the RFP and must be acknowledged in the Proposal response. Only written information provided shall be binding. Oral or other interpretations shall not be binding and are held without legal effect.

F. ANTICIPATED SCHEDULE OF IMPORTANT DATES

The City will generally comply with the following schedule for the selection process, subject to changes necessary to ensure fairness and to accommodate unanticipated events:





Release RFP
Deadline for Questions and Inquiries 5PM CST
Proposals Closing Date and Time 2PM CST
City's Review of Proposals
Earliest Award by City

February 15, 2023
April 13, 2023
April 20, 2023
April 21, 2023 – May 2, 2023
June 1, 2023

G. PRE-PROPOSAL MEETING

A **NON-MANDATORY** Pre-Proposal meeting will be conducted virtually, beginning at 10:00AM CDT on **March 2, 2023**. This meeting is not mandatory. Any questions and answers addressed during the conference meeting will be issued in an addendum and posted on the City website.

Microsoft Teams meeting

Join on your computer, mobile app or room device

[Click here to join the meeting](#)

Meeting ID: 221 980 200 068

Passcode: zVCmSv

[Download Teams](#) | [Join on the web](#)

Or call in (audio only)

[+1 512-672-8405,,681682241#](#) United States, Austin

Phone Conference ID: 681 682 241#

[Find a local number](#) | [Reset PIN](#)

GENERAL TERMS AND CONDITIONS

A. ADDENDA

If it becomes necessary to revise any part of this Request for Proposals, prior to the due date and time, a written addendum will be provided to all known interested Offerors. The City is not bound by any oral representations, clarifications, or changes made in the written specification by the City's employees, unless such clarification of change is provided to Offerors in written addendum form from the City.

Addenda will be transmitted to all that are known to have received a copy of the Request for Proposals and specifications. However, it shall be the sole responsibility of the Offeror to verify issuance of any addenda and to check all avenues of document availability prior to the opening date and time. Offeror shall provide written acknowledgment of all addenda.

B. BUSINESS PRACTICES

Minority business enterprises and/or historically underutilized businesses 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, creed, sex, or national origin in consideration for an award.

C. CERTIFICATION

This Request for Proposals includes a certification page. Offeror must:

1. Furnish complete name, mailing address, telephone number and email of the individual duly authorized to execute contractual documents on behalf of the Offeror.
2. Furnish name of individual(s), along with respective telephone numbers and email addresses, who will be responsible for answering all questions.
3. Certify that they have not conspired with any other potential Offerors in any manner to attempt collusion, conspiracy or otherwise obtain an advantage against the City.

4. Certify that they are duly qualified, capable and otherwise bondable business entity not in receivership or contemplating same and has not filed bankruptcy.

D. COLLUSION

Advanced disclosures of any information to any particular Offeror which gives that particular Offeror any advantage over any other interested Offeror in advance of the opening of Proposals, whether in response to advertising or an informal request for proposals, made or permitted by a member of the governing body or an employee or representative thereof, will cause to void all responses to that particular solicitation or request.

E. COMMUNICATION

To insure the proper and fair evaluation of this Proposal, the City prohibits ex parte communication (e.g., unsolicited) initiated by the Offeror to the City Official or Employee evaluating or considering the Proposals prior to the time an award has been made. Communication between Offerors and the City will be initiated by the appropriate City Official or Employee in order to obtain information or clarification needed to develop a proper and accurate evaluation of the Proposal(s). Ex parte communication may be grounds for disqualifying the offending Offeror from consideration or award, or any future solicitation.

Unless otherwise specified, all requests for clarification or questions regarding a solicitation must be directed as provided herein.

F. DISCLOSURE

All proposals will be kept confidential during the negotiation process. Except for trade secrets and confidential information which Offerors identify as proprietary, all proposals will be open for public inspection after the contract award.

G. DISCLOSURE OF CONFLICT OF INTEREST

Chapter 176 of the Texas Local Government Code requires that any Consultant or person considering doing business with a local government entity disclose the Consultant or person's affiliation or business relationship that might cause a conflict of interest with a local government entity. The Conflict of Interest Questionnaire form is available from the Texas Ethics Commission at www.ethics.state.tx.us. Any completed Conflict of Interest Questionnaires shall be submitted to the City. Any attempt to intentionally or unintentionally conceal or obfuscate a conflict of interest may automatically result in the disqualification of the Offeror.

H. DISCLOSURE OF INTERESTED PARTIES

Contracting hereunder may require compliance with Texas Government Code §2252.908/Disclosure of Interested Parties for contracts that (1) require an action or vote by the City Council before the contract may be signed; or (2) has a value of at least \$1 million. The law provides that a governmental entity may not enter into certain contracts with a business entity unless the business entity submits a disclosure of interested parties to the governmental entity at the time the business entity submits the signed contract to the governmental entity or state agency.

The process as implemented by the Texas Ethics Commission ("TEC") is as follows:

- a. The disclosure of interested parties must be performed using the [Texas Ethics Commission's electronic filing application](#) listing each interested party of which the business entity is aware on [Form 1295](#), obtaining a certification of filing number for this form from the TEC, and printing a copy of it to submit to the City.
- b. The copy of Form 1295 submitted to the City must contain the unique certification number from the TEC. The form must be filed with the City pursuant to Section 2252.908 Texas Government Code, "at the time the business entity submits the signed contract" to the City.
- c. The City, in turn, will acknowledge a copy of the disclosure form to the TEC not later than the 30th day after the date the City receives the disclosure of interested parties from the business entity.

I. EFFECTIVE DATE and TERM

The Agreement shall be effective upon the latter of the following: the Offeror's signature on the Proposal and approval by the City Council, or their designee and issuance of an agreement and shall continue in effect until all obligations are performed in accordance with the terms and conditions herein.

J. EXCEPTIONS

Any deviations from terms, conditions or specifications contained herein must be clearly indicated in the Proposal. Any deviations or exceptions are subject to review by the City and may deem the Proposal disqualified or non-responsive. If no exceptions are stated, it will be understood that all general terms and conditions and specific requirements will be complied with, without exception.

K. INTERLOCAL AGREEMENT

Other governmental entities may be extended the opportunity to purchase from solicitations awarded by the City, with the consent and agreement of the successful Offeror(s) and the City. Such consent and agreement shall be conclusively inferred from lack of exception to this clause in Offeror's Proposal. However, all parties indicate their understanding and all parties hereby expressly agree that the City is not an agent of, partner to or representative of those outside agencies or entities and that the City is not obligated or liable for any action or debts that arise out of such independently negotiated piggyback procurements.

L. MANAGEMENT

Should there be a change in management after the due date and time, but before a contract is awarded, Proposers must notify the City immediately. This may result in further evaluation. Should a change in management occur after the contract is awarded, the contract shall be canceled unless a mutual agreement is reached with the new owner or manager to continue the contract. Any resulting contract is nontransferable by either party.

M. PERSONAL INTEREST

No officer, employee, independent consultant or elected official of the City who is involved in the development, evaluation or decision-making process of this Solicitation shall have a financial interest, direct or indirect, in the resulting Agreement. Any willful violation of this Paragraph shall constitute impropriety in office, and any officer or employee guilty thereof shall be subject to disciplinary action up to and including dismissal. In the event a member of the governing body or an appointed board or commission of the City belongs to a cooperative association, the City may purchase services from the association only if no member of the governing body, board or commission will receive pecuniary benefit from the purchase, other than as reflected as in increase in dividends distributed generally to members of the association. Any violation of this provision with the knowledge, expressed or implied, by the Vendor shall render the Agreement voidable by the City. Nevertheless, the City may obtain the services under the Agreement if a conflict of interest affidavit is filed and the Council member recuses his/herself.

N. PRICE WARRANTY

The Offeror warrants that the prices proposed are fair and reasonable and not higher than those for similar projects of the same size and scope offered to other local governments in the United States.

O. PERFORMANCE AND PAYMENT BONDS

The successful Offeror shall provide a Performance and Payment Bond. Each bond shall be issued in an amount of one hundred percent (100%) of the Contract Amount by a solvent surety or insurance company licensed to do business in the State of Texas and as specifically prescribed in the General Conditions and Supplemental Conditions.

P. PRIORITY of DOCUMENTS

In the event there are inconsistencies between the RFP terms and conditions, scope of work or Agreement terms and conditions contained herein, the latter will take precedence.

Q. PROTEST PROCEDURES

1. Offerors are advised that protests of specifications, terms, conditions or any other aspect of this solicitation, must be made prior to the proposal due date. Protest of specifications and solicitation terms and conditions made after the due date and time will not be considered by the Buyer.
2. Protest of award must be made immediately, and in no event later than five (5) days after the aggrieved party knows, or should have known, the facts giving rise thereto. All protests must include the following information:
 - The name, address and telephone number of the protestor
 - The signature of the protestor or protestor's representative
 - The solicitation or contract number
 - A detailed statement of the legal and/or factual ground of the protest
 - The form of relief/result requested

Protests shall be mailed to the Purchasing Department, P.O. Box 409, Georgetown, TX 78627, Attention: Listed Buyer. Award will be made in the best interest of the City.

R. PUBLIC INFORMATION

All Proposals are subject to release as public information unless the Proposal or specific parts of the Proposal can be shown to be exempt from the Texas Public Information Act. Offerors are advised to consult with their legal counsel regarding disclosure issues and take the appropriate precautions to safeguard trade secrets or any other proprietary information. The City assumes no obligation or responsibility for asserting legal arguments on behalf of potential Offerors.

If an Offeror believes that a Proposal or parts of a Proposal are confidential, then the Offeror shall so specify. The Offeror shall stamp in bold red letters the term "**CONFIDENTIAL**" on that part of the Proposal, which the Offeror believes to be confidential. Vague and general claims as to confidentiality shall not be accepted. All Proposals and parts of Proposals that are not marked as confidential will be automatically considered public information.

S. REIMBURSEMENTS

There is no expressed or implied obligation for the City of Georgetown to reimburse responding Offerors for any expenses incurred in preparing Proposals in response to this Request for Proposals and the City will not reimburse responding Offerors for these expenses, nor will the City pay any subsequent costs associated with the provision of additional information or presentation, or to procure a contract for these goods or services.

T. REPRESENTATIONS and RESPONSIBILITIES

By submitting a Proposal in response to this RFP, Offeror represents that it has carefully read and understands all elements of this RFP; has familiarized itself with all federal, state, and local laws, ordinances, and rules and regulations that in any manner may affect the cost, progress, or performance of the work; and has full knowledge of the scope, nature, quality and quantity of services to be performed.

By submitting a Proposal in response to this RFP, the Offeror represents that it has not relied exclusively upon any technical details in place or under consideration for implementation by the City, but has supplemented this information through due diligence research and that the Offeror sufficiently understands the issues relative to the indicated requirements.

The failure or omission of Offeror to receive or examine any form, instrument, addendum, or other documents or to acquaint itself with existing conditions or other details shall in no way relieve any Offeror from any obligations with respect to its proposal or to the contract.

U. RESERVATIONS

The City reserves the right to request clarification or additional information specific to any Proposal after all Proposals have been received and the solicitation due date has passed. Additionally, the City reserves the right to accept or reject all or part of any Proposal, waive any formalities or technical inconsistencies, delete any portion of the Scope of Work, or terminate the Request for Proposals when deemed to be in City’s best interest.

V. RETAINAGE

Retainage in the amount of five percent (5%) will be withheld pursuant to Texas Government Code § 2252, and such retainage will be withheld until thirty (30) days after Final Completion.

W. SALES AND USE TAXES

OWNER is exempt from Texas state sales and use taxes on materials and equipment to be incorporated in the Work, pursuant to the provisions of Section 151.309(5) of the Texas Tax Code. Said taxes shall not be included in the Proposal. Refer to paragraph 6.10 of the General Conditions for additional information

X. SUBSTITUTE AND “OR EQUAL” ITEMS

The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Proposal Documents without consideration of possible substitute or “or equal” items. Whenever it is specified or described in the Proposal Documents that a substitute or “or equal” item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by CONTRACTOR and consideration by ENGINEER is set forth in the General Conditions and may be supplemented in the General Requirements.

Y. SUBCONTRACTORS, SUPPLIERS, AND OTHERS

Offeror shall identify the major Subcontractors Offeror proposes for this Project in Section 00400 Statement of Proposer’s Experience. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity as provided on Attachment E of Statement of Proposer’s Experience. If OWNER or ENGINEER, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, OWNER may, before the Notice of Award is given, request apparent Successful Offeror to submit a substitute, in which case apparent Successful Proposer shall submit an acceptable substitute.

If apparent Successful Proposer declines to make any such substitution, OWNER may award the Contract to another Proposer that proposes to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Proposer. Any Subcontractor, Supplier, individual, or entity so listed and against which OWNER or ENGINEER makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to OWNER and ENGINEER subject to revocation of such acceptance after the Effective Date of the Agreement as provided in paragraph 6.06 of the General Conditions.

CONTRACTOR shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom CONTRACTOR has reasonable objection.

Z. SECURITY

Offerors must submit with their Proposal, a Cashiers Check or a Certified Check, drawn on a bank or trust company authorized to do business in the State of Texas, payable to the City of Georgetown in the amount at least equal to five percent (5%) of the maximum amount of Proposal Price, as a guarantee that a contract will be entered into or in lieu of cash or certified check, the Offeror may submit a Proposal Bond in the form prescribed in Section 00410 of the Documents.

AA. STANDARD FORM of AGREEMENT

The City's Standard form of Agreement is attached as Exhibit A. The successful Firm will be required to execute this Agreement. All Proposers shall be required to thoroughly read and understand the terms, condition and provisions in this Agreement. All required Certificates of Insurance and endorsements will be required before award recommendation is taken to City Council. Any exceptions taken to the City's Standard Form of Agreement must be indicated in your Response. Failure to note any exceptions will be acknowledgement that you accept the terms and condition without modifications.

BB. WITHDRAWAL by CITY

The City makes no guarantees or representations that any award will be made and reserves the right to cancel this solicitation for any reason, including:

- Reject any and all Proposals received as a result of this RFP.
- Waive or decline to waive any informality and any irregularities in any Proposals received.
- Negotiate changes in the Scope of Work or services to be provided.
- Withhold the award of contract(s).
- Select Offeror(s) it deems to be most qualified to fulfill the needs of the City. Offeror(s) with the lowest priced proposal(s) will not necessarily be selected, since a number of criteria other than price are important in the determination of the most acceptable proposal(s).
- Terminate the RFP process.

CC. WITHDRAWAL by OFFEROR

Respondents may request withdrawal of a sealed Proposal ***prior to the scheduled opening time***, provided the request for withdrawal is submitted to the City in writing.

DD. VENUE

Any contract awarded as a result of this RFP shall be governed by and construed in accordance with the laws of the State of Texas, and is fully performable in Georgetown, Texas, and venue for any action related to this contract will be Williamson County, Texas.

SPECIAL TERMS and CONDITIONS

A. TERMS OF AGREEMENT

The Standard Form of Agreement, General Conditions, and Supplementary Conditions are attached to this RFP as Exhibit 00500.

BACKGROUND and CURRENT CIRCUMSTANCES

A. CITY of GEORGETOWN

Georgetown is a Home Rule Charter City and operates under a Council - Manager form of government. A mayor, elected at large, and seven Council members, elected from single member districts, serve staggered, three-year terms. Georgetown is located on Interstate 35, the major corridor between Dallas and San Antonio, at the intersection of State Highway 130. Georgetown was founded in 1848 with a strong agricultural base, in the heart of Williamson County, 26 miles north of Austin. Today, Georgetown has an estimated population of 74,180 within the city limits, with an estimated population of 93,961 within the extra-territorial jurisdiction (ETJ) and serves as the county seat of Williamson County.

Georgetown's economic development initiatives to expand jobs and tax base have been with a careful focus of maintaining and expanding its status as a signature destination. The award- winning historic downtown square, along with its extensive, award-winning parks and river trail systems along the North and South San Gabriel Rivers and Lake Georgetown have been leveraged to make the City one of the most attractive places to live and work.

This unique character and small-town charm were key factors for Del Webb Corporation when it built its first Texas development in Georgetown with the 1995 opening of Sun City, Texas. Today, over 7,200 homes with over 13,500 retirees make Sun City and Georgetown their home.

Georgetown is also home to Southwestern University, which continues to receive national recognition. The University has been named to Kiplinger's list of the 100 best values in liberal arts colleges and has been noted as one of 'America's Best Value Colleges' by the *Princeton Review*. With more than 1,528 students and over 500 employees, the University provides substantial economic and cultural contributions to Georgetown.

B. ESTIMATED BUDGET

The City has established fifteen million and NO/100 Dollars (\$15,000,000) as the estimated construction budget for all the Work including alternates as described in the Drawings, Technical Specifications, and other Contract Documents prepared by the ENGINEER.

C. ESTIMATED CONSTRUCTION TIME

The Construction time is identified in Section 00500 Standard Form of Agreement Between Owner and Contractor for Construction Contract in Article 3.

D. SUBSURFACE AND PHYSICAL CONDITIONS

The Supplementary Conditions (Exhibit 00800) identify:

1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the RFP Documents.
2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that ENGINEER has used in preparing the RFP Documents.

Copies of reports and drawings referenced in paragraph D.1 above will be made available by ENGINEER to any Proposer on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Proposer is entitled to rely as provided in paragraph A1. Proposer is responsible for any interpretation or conclusion Proposer draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

E. UNDERGROUND FACILITIES

Information and data shown or indicated in the RFP Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to OWNER and ENGINEER by owners of such Underground Facilities, including OWNER, or others.

SCOPE OF WORK

SCOPE OF WORK

A. General

The project consists of furnishing, installing, and providing all labor and materials required for construction of rehabilitation improvements to the 2.5 million gallons per day San Gabriel Wastewater Treatment Plant, as more fully described in the Drawings and the Summary of Work contained in Section CIP3.

B. Construction Documents

Construction Plans and Specifications for San Gabriel WWTP Rehabilitation are provided with this RFP, stamped and signed January 2023.

EVALUATION and SELECTION PROCESS

As this is a solicitation by Competitive Sealed Proposals, the City will select an Offeror whose Proposal is determined to be the most advantageous to the City considering the relative importance of price and the other evaluation factors included in this Request for Proposals.

The City has attempted to provide a comprehensive statement of requirements through this RFP for the work contemplated. Written proposals must present Offeror's qualifications and understanding of the work to be performed. Offerors are asked to address each evaluation criteria and to be specific in presenting their qualifications. Proposals must be as thorough and detailed as possible so that the City may properly evaluate capabilities to provide the requested services.

By submission of a proposal, Offeror acknowledges acceptance of the evaluation process, the evaluation criteria, scope of work, approach and methodology, and all other terms and conditions set forth in this RFP. Further, Offerors acknowledge that subjective judgements must be made by the City during this process.

The evaluation process may include, but is not limited to, the following steps. Steps may be omitted or reordered depending on the proposal evaluation requirements. For example, Best and Final Offers may be required prior to Interviews and/or Presentations.

A. CLARITY AND QUALITY OF PROPOSAL

Pass/Fail

Offerors must provide comprehensive responses to every section within this RFP in the described format. It is not the intent of the City to constrain Offerors with regard to content, but to assure that the specific requirements set forth in this RFP are addressed in a uniform manner amenable to review and evaluation. Failure to do so may result in your Proposal being disqualified from further review and consideration.

B. PROPOSAL EVALUATIONS

The City has established specific, weighted criteria for selection. This section presents the evaluation criteria, description, and relative weight assigned to each (100 points maximum). The City will evaluate each Offeror's responses to the requirements contained in this RFP.

Evaluation of proposals that meet the minimum requirements will be carried out by an evaluation team consisting of a minimum of five (5) City of Georgetown project team members. These team members will assign rating values to each of the criteria that range from 0-5, distributed as shown below:

- 5 = Exceeds Expectations
- 4 = Above Expectations
- 3 = Meets Expectations
- 2 = Does not quite Meet Expectations
- 1 = Does not meet Expectations
- 0 = Non-responsive or does not meet Minimum Requirements

The average of the team members' individual rating values will be multiplied by the relative weighting points for each of the criteria below, and the total used to rank the Proposers. The Proposer with the highest ranking will be considered the Proposer that provides the best value to the City and will be recommended to the City for Contract Award.

C. COST EVALUATION

Price shall be considered but shall not be the sole determining factor.

3

Cost Proposal

80 points total

- i. Proposer with the lowest price will be awarded a 5-rating value. All other offerors will be awarded a rating value calculated by dividing the low bid by the proposer's offering and multiplying that ratio times eighty (80).

D. CONTRACTOR'S EXPERIENCE AND QUALIFICATIONS

10 points total

3

- i. Points will be awarded based on the Offeror's experience relative to the Project, the reputation of the Offeror in similar past projects, and overall reputation and experience of the Offeror.
- ii. The Owner will evaluate the projects submitted per Exhibit 00400 Part 3 – EXPERIENCE REQUIREMENTS to determine relevancy to the specified scope of this Project and review the Offeror's performance on the submitted projects.
 - a. Offeror must provide evidence of a minimum of three (3) successfully completed water or wastewater treatment plant installation projects of comparable size (minimum value of \$10 million), complexity, and scope (at least two projects must be at operational wastewater treatment plants) within the United States successfully completed by the Offeror within the past Ten (10) years.
 - i. The Owner may contact the past project references, as may be necessary to verify the qualifications, experience, and reputation of the Offeror. This requirement can be met through the employment of a qualified subcontractor.
 - b. The Owner will also evaluate:
 - i. The Proposer's Information as presented in Attachment A.
 - ii. The list of equipment available to the Contractor and specifically intended to be used on the Work as presented in Attachment E.
 - iii. The list of the available workforce for the various disciplines and crafts as presented in Attachment F.
 - iv. The list of all current projects of the Contractor as presented in Attachment G.

- v. The Contractor’s list of all completed projects as presented in Attachment H.

E. CONTRACTOR’S KEY PERSONNEL

10 points total



- i. Offeror will be awarded points based on the experience of the proposed key personnel, with a maximum score of ten (10) points for a team that demonstrates all desirable characteristics.
 - a. Per Exhibit 00400 Part 3 – EXPERIENCE REQUIREMENTS, key personnel will be evaluated for experience with the type and scope of work required for this Project, previous work history as a team, definition of roles in previous experience, length of time with the company, and the percent of time allocated to the project as presented in Attachment C – Statement of Experience for Proposer’s Key Personnel.”

F. REFERENCE CHECKS

The City reserves the right to check any reference(s), regardless of the source of the reference information. Information may be requested and evaluated from references. The City reserves the right to use a third party to conduct reference checks. Only top scoring Offerors may receive reference checks and negative references may eliminate Offerors from further consideration.

G. EVALUATION and RANKING

Following the Technical and Cost proposal evaluation, the City will compile the final scores. If the Evaluation Committee determines that clarifying information is not required, the evaluation process is complete. The award recommendation will be made to the Offeror which, in the City’s opinion, has submitted the Proposal most beneficial to the City for award.

H. VENDOR SELECTION

Contract negotiations will begin with the highest ranked Offeror(s) following any presentations and/or interviews. Should negotiations with the highest ranked Offeror fail to yield a contract, or if the Offeror is unable to execute the City’s contract, negotiations will be formally ended and then commence with the second highest ranked Offeror, etc. The City, may, in its sole discretion, negotiate and award a contract without presentations or interviews, based solely on information supplied in the proposal responses. The City may, at its option, request best and final offers from one or more Offerors.

SUBMISSION REQUIREMENTS

The City will not accept hard copy or oral proposals, or proposals received by telephone or FAX machine. Proposals must be prepared simply and economically, providing a straightforward, concise description of Offeror's ability to meet all requirements and specifications of this RFP. Emphasis should be focused on completeness, clarity of content and responsiveness to all requirements and specifications of this RFP.

Refer to <https://georgetown.ionwave.net/Login.aspx> for further information on how to submit proposals electronically.

The City of Georgetown requires comprehensive responses to every section within this RFP. To facilitate the review of the responses, Offerors shall follow the described format. The intent of the proposal format is to expedite review and evaluation. It is not the intent to constrain Offerors with regard to content, but to assure that the specific requirements set forth in this RFP are addressed in a uniform manner amenable to review.

The submission of a Proposal will constitute an incontrovertible representation by Proposer that Proposer has complied with every requirement of this RFP, that without exception the Proposal is premised upon performing and furnishing the Work required by the RFP Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the RFP Documents.

A. EXHIBIT 0300 PROPOSAL FORM

Complete and submit Exhibit 00300 Proposal Form.

B. EXHIBIT 00400 – STATEMENT OF PROPOSER'S EXPERIENCE,

Complete and submit Exhibit 00400 and it would be preferred that this information be included with the proposal. If desired, the experience descriptions may be provided no later than 24 hours after the opening at the Purchasing Office with the Proposal's name and Project name included on the envelope.

C. EXHIBIT 00410 PROPOSAL BOND

Complete and submit Exhibit 00410 Proposal Bond.

D. CERTIFICATION and ACKNOWLEDGEMENT PAGES

Complete and include the Certification and Acknowledgment on page 15 of the RFP and Certification Required by Texas Government Code Chapter 2270 on page 16 of this RFP.

CERTIFICATION and ACKNOWLEDGEMENT

The undersigned affirms that they are duly authorized to submit this Proposal, that this Proposal has not been prepared in collusion with any other Offeror, and that the contents of this Proposal have not been communicated to any other Offeror prior to the official opening. Further, Offeror certifies that Offeror is not engaged in business with Iran, Sudan, or a foreign terrorist organization.

Signed By: _____ Title: _____

Typed Name: _____ Company Name: _____

Phone No.: _____ Fax No.: _____

Email: _____

Proposal Address: _____
P.O. Box or Street City State Zip

Order Address: _____
P.O. Box or Street City State Zip

Remit Address: _____
P.O. Box or Street City State Zip

Federal Tax ID No.: _____

DUNS No.: _____

Date: _____

CERTIFICATION REQUIRED BY TEXAS GOVERNMENT CODE

The undersigned makes the following certifications or represents that it satisfies the requirements of one or more exceptions to the Texas Government Code provisions listed below:

1. **Contractor Certification Regarding Boycotting Israel.** Pursuant to Chapter 2271, Texas Government Code, Firm certifies that it (1) is a sole proprietorship or company with fewer than ten (10) employees; **or** (2) does not currently boycott Israel and will not boycott Israel during the term of this Agreement.
 - 1.1. Exception: This provision only applies to contracts for goods and services between a governmental entity and a Company with ten (10) or more full-time employees with a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.
2. **Contractor Certification Regarding Business with Certain Countries and Organizations.** Pursuant to Subchapter F, Chapter 2252, Texas Government Code, Firm certifies it (1) is a "Company," as that term is defined in Texas Government Code Section 806.001; and (2) is not engaged in business with Iran, Sudan, a foreign terrorist organization, or any company that is identified on a list prepared and maintained under Texas Government Code Section 806.051, 807.051, or 2252.153.
 - 2.1. Exception: A company that the United States government affirmatively declares to be excluded from its federal sanctions regime relating to Sudan, its federal sanctions regime relating to Iran, or any federal sanctions regime relating to a foreign terrorist organization is not subject to contract prohibition under this subchapter.
3. **Contractor Certification Regarding Boycotting Energy Companies.** Pursuant to Chapter 2274, Texas Government Code, Firm certifies that either (1) is a sole proprietorship or company with fewer than ten (10) employees; **or** (2) Firm does not currently boycott energy companies and will not boycott energy companies during the Term of this Agreement.
 - 3.1. Exception: This provision only applies to contracts for goods and services between a governmental entity and a Company with ten (10) or more full-time employees with a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.
4. **Contractor Certification Regarding Boycotting Firearm and Ammunition Industries.** Pursuant to Chapter 2274, Texas Government Code, Firm certifies that either (1) Contractor is a sole proprietorship or company with fewer than ten (10) employees; **or** (2) Firm does not currently boycott firearm and ammunition industries and will not boycott firearm and ammunition industries during the term of this Agreement.
 - 4.1. Exception: This provision only applies to contracts for goods and services between a governmental entity and a Company with ten (10) or more full-time employees with a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.
5. **Contractor Certification Regarding Doing Business in Texas.** Firm certifies that it has not been debarred from doing business in the State of Texas.

Firm acknowledges this Agreement may be terminated and payment withheld if this certification is inaccurate. For purposes of this form, the terms have the meanings assigned by Texas Government Code sections referenced above.

Signed By: _____ Title: _____

Typed Name: _____

Company Name: _____

Date: _____

COMPLETE THIS SECTION ONLY IF YOU BELIEVE YOU ARE NOT REQUIRED TO PROVIDE THE WRITTEN
CERTIFICATION LISTED ABOVE FOR THE REASONS CITED BELOW.

Firm is not required to provide the certifications listed above because of the following exemptions (explain the specific exemptions that apply pursuant to the applicable Chapter of the Texas Government Code):

EXHIBIT 00300
PROPOSAL FORM

**SECTION 00300
PROPOSAL FORM**

PROPOSER'S NAME: _____

PROJECT IDENTIFICATION:

City of Georgetown
Project Name: San Gabriel WWTP Rehabilitation
Project Address: 1107 N College St, Georgetown, TX

SAN GABRIEL WWTP PROJECT NUMBER: PRJ000165
PROPOSAL NUMBER: 202305
CONTRACT NUMBER: 23-0041CIP

THIS PROPOSAL IS SUBMITTED TO:



City of Georgetown
Georgetown Municipal Complex, Purchasing Department
510 W. 9th Street
Georgetown, Texas 78626

- 1.01 The undersigned Proposer proposes and agrees, if this Proposal is accepted, to enter into an Agreement with OWNER in the form included in the Request for Proposal (RFP) Documents to perform all Work as specified or indicated in the RFP Documents for the prices and within the times indicated in this Proposal and in accordance with the other terms and conditions of the RFP Documents.
- 2.02 PROPOSER understands and agrees that the OWNER has the right to reject any or all Proposals and to waive any minor technicalities.
- 2.01 Proposer accepts all of the terms and conditions of Section 100, including without limitation those dealing with the disposition of Security. The Proposal will remain subject to acceptance for 120 days after the Proposal opening, or for such longer period of time that Proposer may agree to in writing upon request of OWNER.
- 3.01 In submitting this Proposal, Proposer represents, as set forth in the Agreement, that:
 - A. Proposer has examined and carefully studied the RFP Documents, the other related data identified in the RFP Documents, and the following Addenda, receipt of all which is hereby acknowledged.

<u>Addendum No.</u>	<u>Addendum Date</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

- B. Proposer 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. Proposer is familiar with and is satisfied as to all federal, state and local laws and regulations that may affect cost, progress and performance of the Work.
 - D. Proposer has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in paragraph 4.02 of the General Conditions, and (2) reports and drawings of a Hazardous Environmental Condition, if any, which has been identified in the Supplementary Conditions as provided in paragraph 4.06 of the General Conditions.
 - E. Proposer has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Proposer, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the RFP Documents to be employed by Proposer, and safety precautions and programs incident thereto.
 - F. Proposer does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Proposal for performance of the Work at the price(s) Proposal and within the times and in accordance with the other terms and conditions of the RFP Documents.
 - G. Proposer is aware of the general nature of work to be performed by OWNER and others at the Sites that relates to the Work as indicated in the RFP Documents.
 - H. Proposer has correlated the information known to Proposer, information and observations obtained from visits to the Sites, reports and drawings identified in the RFP Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the RFP Documents.
 - I. Proposer has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that Proposer has discovered in the RFP Documents, and the written resolution thereof by ENGINEER is acceptable to Proposer.
 - J. The RFP Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Proposal is submitted.
- 4.01 Proposer further represents that this Proposal is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Proposer has not directly or indirectly induced or solicited any other Proposer to submit a false or sham Proposal; Proposer has not solicited or induced any individual or entity to refrain from proposing; and Proposer has not sought by collusion to obtain for itself any advantage over any other Proposer or over OWNER.
- 5.01 Proposer will complete the Work in accordance with the Contract Documents for the following price(s):

**SCHEDULE OF PRICES FOR
CITY OF GEORGETOWN
San Gabriel WWTP Rehabilitation**

PROPOSAL ITEM NO. 1: Insurance, Bonds and **Mobilization/Demobilization** Related Expenses not to exceed 5% of Total Proposal Price.

Lump Sum \$ _____
(FIGURES)

(WRITTEN)

PROPOSAL ITEM NO. 2: Furnish all necessary labor, materials, equipment and incidentals necessary to construct the **San Gabriel WWTP Rehabilitation** for improvements to the 2.5 million gallons per day San Gabriel Wastewater Treatment Plant, as more fully described in the Drawings and the Summary of Work contained in Section CIP3. This item shall include all work as specified and shown on the Drawings including all ancillary equipment, complete in place including incidental work obviously needed for the complete project, except those costs specifically included in the other items in this Schedule of Prices.

Lump Sum \$ _____
(FIGURES)

(WRITTEN)

3

BASE BID ITEM NO. 3: Design, furnish, install, maintain and remove Trench Excavation Safety Systems as required in all trenches deeper than five feet deep, complete in place as detailed and specified, including overhead and profit associated therewith.

* _____ L.F. @ \$ _____ /L.F. \$ _____
(FIGURES)

(WRITTEN)

* Maximum linear feet to be determined by Proposer and entered here. Linear footage shall not be less than 100 L.F.

3

BASE BID ITEM NO. 4: Design, furnish, install, maintain and remove Structure Excavation Safety Systems as required in all structure special shoring excavation systems, greater than five feet deep, complete in place as detailed and specified, including overhead and profit associated therewith.

** _____ S.F. @ \$ _____ /S.F. \$ _____
(FIGURES)

(WRITTEN)

** Maximum square feet to be determined by Proposer and entered here. Square footage shall be not less than 100 S.F.

3

PROPOSAL ITEM NO. 5: An allowance for purchasing the equipment and materials associated with the **Stacked Tray Grit Removal Equipment and Appurtenances** in accordance with Section 462323. Proposer shall include in Proposal Item No. 2 the installation cost, materials, overhead, and profit for

installing, field testing, and making ready for operation the equipment and materials furnished under Section 462323.

Lump Sum \$ 274,050
(FIGURES)

Two Hundred and Seventy-Four Thousand and Fifty Dollars and No Cents
(WRITTEN)

PROPOSAL ITEM NO. 6: Furnish all necessary labor, materials, equipment and incidentals necessary to perform **Removal, Loading, Transport, and Disposal** of wastewater solids, grit, rags, and debris from the facilities to be modified including the Aeration Basins, Influent Lift Station Wet Well, Irrigation Water Clearwell, Aerated Sludge Holding Tank, and Grit Chamber and all other related work complete in place as detailed on the Drawings and as specified in Section 460200 “Tank and Structure Cleaning” except those costs specifically included in other items in this Schedule of Prices.

Estimated Quantity: 600 WET TONS

Unit Price per \$/WET TON: \$ _____
(FIGURES)

Total Amount: \$ _____
(FIGURES)

(WRITTEN)

PROPOSAL ITEM NO. 7: Furnish all necessary labor, materials, equipment and incidentals necessary to construct the new **Electrical Improvements**, including all site electrical work including electrical demolition, electrical service, motor control centers (MCC), switchgear, panelboards, new Coordinated E-houses, emergency power supply generator, generator access platform, circuit breakers, transformer, and all electrical power distribution and control system conduit, duct banks, miscellaneous wiring, terminations, lighting fixtures, and electrical components, coordination with electric service provider, and all required appurtenances required for a complete and operational system, and all other related work complete in place as detailed on the drawings and/or as specified, except those costs specifically included in other items in this Schedule of Prices.

Lump Sum \$ _____
(FIGURES)

(WRITTEN)

PROPOSAL ITEM NO. 8: Furnish all necessary labor, materials, equipment and incidentals necessary to construct the new **SCADA/Instrumentation and Control Improvements**, including modification of the existing SCADA system, furnishing and installing of all materials, equipment, software, labor and services required to install and configure all instrumentation and field wiring for all proposed work included in this contract. Design, coordinate, program, and modify the existing process control system for proper operation with equipment and materials furnished under this contract including PLC programming, HMI configuration, graphics development, historical logging software application and report generation, network configuration and programming, and all other related work complete in place as detailed on the drawings and/or as specified, except those costs specifically included in other items in this Schedule of Prices.



Lump Sum \$ _____
(FIGURES)

(WRITTEN)

PROPOSAL ITEM NO. 9: Allowance for fence relocation at San Gabriel WWTP, as needed.

Lump Sum \$10,000.00 _____
(FIGURES)

Ten Thousand Dollars and No Cents _____
(WRITTEN)

PROPOSAL ITEM NO. 10: Allowance to be used for paying fees and charges for permanent electrical service from Georgetown Utility Systems. Refer to Drawing E-3 (Electrical General Notes), Service and Metering notes. The cost for the work to be performed shall be negotiated and Contractor shall be paid for the work out of this allowance:

Lump Sum \$150,000.00 _____
(FIGURES)

One Hundred and Fifty Thousand Dollars and No Cents _____
(WRITTEN)

PROPOSAL ITEM NO. 11: Owner-directed improvements are considered provisional amounts to be used only if directed and are exclusive of work indicated in the Contract Documents for which payment is included in other items in the Schedule of Prices. Contractor's cost for bonds, insurance, overhead, profits, etc. associated with this allowance shall be included in the lump sum Proposal items above; no mark-up shall be allowed for these funds.

Lump Sum \$100,000.00 _____
(FIGURES)

One Hundred Thousand Dollars and No Cents _____
(WRITTEN)

TOTAL PROPOSAL (TOTAL OF ITEMS 1-11) \$ _____
(FIGURES)

(WRITTEN)

(WRITTEN)



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The above Prices shall include all labor, materials, bailing, shoring, removal, overhead, profit, insurance, etc., to cover the finished work of the several kinds called for. The Proposer understands that the Owner reserves the right to reject any or all Proposals and to waive any informalities in the RFP Documents.

Unit Prices have been computed in accordance with paragraph 11.03.B of the General Conditions.

Proposer acknowledges that estimated quantities are not guaranteed, are solely for the purpose of comparison of Proposals, and final payment for all Unit Price Proposal items will be based on actual quantities provided, determined as provided in the Contract Documents.

SCHEDULE OF MATERIALS AND SUPPLIERS

The Contract Documents are based upon the equipment or products available from the manufacturers/suppliers denoted within the specifications. The Proposal must be based on the manufacturers or suppliers included in the specifications. Proposers shall circle the manufacturers included in the Proposal as shown on the Proposal Equipment table. If nothing is circled, then it shall be the first manufacturer listed that is expected to be provided.

Provision is made in the Contract Documents for alternate manufacturers and suppliers whose equipment or product may be deemed equivalent in quality. If the Proposer desires to propose one or more alternate manufacturers/suppliers, the Proposer may write in the name of such alternates in the spaces provided on the attached schedule. Wherever an alternate manufacturer/supplier is proposed, the Proposer must insert the amount to be deducted from the Contract Price (either lump sum or unit price) if the alternate manufacturer/supplier is eventually approved.

If the Owner determines that it is in the best interest of the project to review the alternate manufacturer, then the Owner will request that the Proposer supply complete information on proposed alternates for review prior to the Notice of Award. If the proposed alternate manufacturer/supplier is not determined to be in the best interest for this project or is not acceptable to the Owner or Engineer, the Proposer shall use their circled specified manufacturers or suppliers.

The deductive amount specified for alternate manufacturers/suppliers will not be used in determining the successful Proposer. Alternates will be considered only after award of the Contract.

For any alternate manufacturer or supplier accepted by the Owner, the Contract Price will be reduced by the deductive amount stated in the Proposal. However, because the Contract Price is based on specified manufacturers/suppliers it will not be adjusted for any alternate supplier rejected.

The Contractor shall reimburse the Owner for any costs directly attributable to the change in manufacturer or supplier, such as additional field trips for the Engineer, additional redesign costs, additional review and inspection costs, etc.

PROPOSAL EQUIPMENT

3

Equipment Item or Material	Spec Section	Manufacturer/Supplier
Multi-Rake Bar Screen	462113	a. Kusters Water b. Huber c. Headworks d. Vulcan
Lift Station Submersible Pumps	432513	a. Wilo b. Pentair (Hydromatic/ Myers)
Stacked Vortex Tray Grit Equipment	462323.11	a. Hydro International
Grit Classifying and Washing Equipment	462363	a. Hydro International b. Huber
Recessed Impeller Grit Handling Pumps	432335	a. Wemco b. Egger
Multistage Centrifugal Blowers	431118	a. Lone Star Blower b. Continental c. Hoffman Lamson Gardner Denver
Rotary Lobe Positive Displacement Blowers	431133	a. Aerzen b. Universal Blower PAC c. Hoffman Lamson Gardner Denver d. Kaeser
Ceramic Disc Fine Bubble Diffusers	465136	a. ITT-Sanitaire Xylem b. Aquarius Technologies c. EDI
Coarse Bubble Diffusers	465121	a. ITT-Sanitaire Xylem b. Aquarius Technologies c. EDI
Peristaltic Metering Pumps	432880	a. Watson Marlow b. Blue-White
Stainless Steel Slide Gates	400559.23	a. Whipps b. RW Gate
Programmable Logic Controllers		a. Allen-Bradley

ALTERNATE MANUFACTURERS/SUPPLIERS

Proposer proposes the following alternate manufacturers and suppliers for the equipment or material categories identified:

Equipment Item or Material	Drawing No.	Spec. Section	Alternative Manufacturer/Supplier (List One Only)	Deductible Amount (Indicate whether lump sum or unit price)
1.				
2.				
3.				
4.				
5.				

SCHEDULE OF SUBCONTRACTORS

Proposer proposes the following subcontractors to be used for the Project. All subcontractor specialties indicated below and any subcontractors that, due to the nature of the construction work, comprise a critical or essential element of the construction such that the amount of the subcontract is equal to or greater than 10% of the construction budget or \$50,000, whichever is greater must be listed and submitted with the Proposal. Proposers shall provide the address and phone number for each subcontractor listed and three (3) references for similar size and type of project (Attachment D of Section 00400) with the Proposal in accordance with Section 00100. The references shall include name of project, and contact information, including name, phone number and address, for the Owner, Engineer and General Contractor for each project. Failure to provide this information by the specified date and time will disqualify the Proposal from consideration.

Proposer may change subcontractors after Proposal submittal only as approved in writing by the Engineer. The information provided will be used in the evaluation of the Proposer.

SUBCONTRACTOR	SPECIALTY
1.	Electrical
2.	Instrumentation
3.	
4.	
5.	

6.01 Proposer agrees that the Work will be substantially complete and fully complete project and ready for final payment as noted in Section 00500.

6.02 Proposer accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the times specified above, which shall be stated in the Agreement.

7.01 The following documents are attached to and made a condition of this Proposal:

A. Required Proposal security in the form of _____.

B. Section 00400, Statement of Proposer's Experience, including Attachments A – I.

8.01 The terms used in this Proposal with initial capital letters have the meanings indicated in the Instructions to Proposers, the General Conditions, and the Supplementary Conditions.

SUBMITTED on _____, 20____.

If Proposer is:

An Individual

Name (typed or printed): _____

By: _____ (SEAL)
(Individual's signature)

Doing business as: _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

Type (General Business, Professional, Service, Limited Liability): _____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(CORPORATE SEAL)

Attest _____

(Signature of Corporate Secretary)

Business address: _____

Phone No.: _____ FAX No.: _____

Date of Qualification to do business is _____.

A Joint Venture

Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

Joint Venturer Name: _____ (SEAL)

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

Phone and FAX Number, and Address for receipt of official communications:

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

EXHIBIT 00400

STATEMENT OF PROPOSER'S EXPERIENCE

PROPOSER'S NAME: _____

Project Name: San Gabriel WWTP Rehabilitation

All questions on this form must be answered and data given must be clear and comprehensive. If necessary, questions may be continued on separately attached sheets.

PART 1, PART 2, and PART 3 below are to be submitted as part of the Proposal.

PART 1 – GENERAL

1.1 Proposer must submit Attachments A through J contained in this Statement of Proposer's Experience form signed and notarized within 24-hours of its Proposal. Failure to do so will constitute an incomplete Proposal, which will be rejected.

1.2 The Proposer and OWNER agree that, in determining the Proposal to be the most advantageous to the City, the responsibility of the Proposers will be considered in awarding a Contract for this Project. In connection therewith, all Proposers are required to submit a set of additional completed attachments to the Statement of Proposer's Experience Form for the OWNER's consideration.

PART 2 – PROPOSER'S INFORMATION

2.1 Proposer's Information

In order to submit a responsive Proposal, Proposer must answer all questions completely and all information must be clear, accurate and comprehensive. If necessary, questions may be answered on separate attached sheets. **The forms to complete this requirement are attached hereto as Attachment A.**

PART 3 – EXPERIENCE REQUIREMENTS

The Proposer must provide the following information with its Proposal:

3.1 In order to submit a responsive Proposal, the Proposer must provide evidence of a minimum of three (3) successfully completed water or wastewater treatment plant installation projects of comparable size (minimum value of \$10 million), complexity, and scope (at least two projects must be at operational wastewater treatment plants) within the United States successfully completed by the Proposer within the past Ten (10) years. This documentation shall be presented sufficiently and completely to demonstrate that water or wastewater treatment plant installations are a primary business focus and service provided by the Proposer, and that such services have been successfully provided by the Proposer for at least Ten (10) continuous year(s). The forms to complete this requirement are attached hereto as Attachment B.

If the Proposer chooses to fulfill any of the specific experience requirements listed in this document with subcontracted resources, the Proposer must indicate so on Attachment B, to be submitted with its Proposal, in accordance with this RFP. Additionally, Attachments E and I must be submitted with its Proposal in accordance with paragraph 1.1, above, and in accordance with this RFP.

3.2 In order to submit a responsive Proposal, the Proposer shall provide information on the experience of its proposed staff by completing Attachment C. The submitted Attachment C should include information and resumes for the proposed staff for the project. **The forms to complete this requirement are attached hereto as Attachment C.**

The Proposer shall provide the following information at the time of Proposal.

- 3.3** The same requirements shall apply to each Major Subcontractor proposed for this project, refer to Proposal Form for Major Subcontractor list included in Section 00100. Should it be the intention of the Proposer to perform all or a portion of these services with its own forces, the Proposer shall provide previous project experience in the respective section demonstrating that the Proposer has previously successfully performed these services. Proposer must provide information on each major Subcontractor by completing Attachment D, located at the end of this Section. **The forms to complete this requirement are attached hereto as Attachment D.**
- 3.4** The OWNER seeks CONTRACTORS that can complete the Work within the Contract time given for completion. Anything that might negatively impact a Proposer's ability to timely complete the Work may result in the Proposer being determined to not be the most responsible Proposer.
- 3.6** A completed Attachment E (located at the end of this section) providing a list of equipment that is available to the CONTRACTOR / Subcontractor(s) and specifically intended to be used on the Work under this Contract, and notification whether the equipment is owned or to be leased by the CONTRACTOR and/or Subcontractor(s).
- 3.7** A completed Attachment F (located at the end of this section) providing a list of the available workforce for the various disciplines and crafts required for the Work on this project including the number of work crews, and number of employees anticipated to be assigned to the project.
- 3.8** A completed Attachment G (located at the end of this section) providing a list of all current projects, including *all City of Georgetown projects*. Include the following: a brief statement regarding the job type, the estimated project duration, project contact, and project description of all jobs that Proposer is currently committed to or are currently underway.
- 3.9** A completed Attachment H (located at the end of this section) providing a list of all completed projects, including *all City of Georgetown projects*. Include the following: a brief statement regarding the job type, the estimated project duration, project contact, and project description of the jobs that Proposer has completed in the past Ten (10) years by calendar year or life of company if less than Ten (10) years.

3.10 Authentication

The Proposer must authenticate and acknowledge the preceding information by providing witness in the presence of a notary public duly licensed and authorized to act in that capacity under the laws and statutes of the State of Texas, on the form provided on the following page. **The forms to complete this requirement are attached hereto as Attachment A through I.**

Attachment A
PROPOSER'S INFORMATION

(To be returned with the Proposal)

Proposer must answer all questions completely and all information must be clear, accurate and comprehensive. If necessary, questions may be answered on separate attached sheets.

- A. Name of Proposer: _____

- B. Proposer's Permanent Address: _____

- C. Proposer's Phone No.: _____

- D. Number of years in business under current company name: _____

(Note: A minimum of Ten (10) year's existence as a business is required under the current company name. Changes in company name during the experience period are acceptable if the continuity of the company structure can be demonstrated. Attach separate documentation, if applicable.)

If response is "YES" for questions E – H, attach brief description or explanation

- E. Has the Proposer ever defaulted on a contract?
YES (____) NO (____)

- F. Are there currently any judgments, claims, or lawsuits pending against the Proposer?
YES (____) NO (____)

- G. Does Proposer currently have any claims, judgments or lawsuits pending against any prior client?
YES (____) NO (____)

- H. Is the Proposer or principals of Proposer now, or has the Proposer or principals of Proposer ever been, involved in any bankruptcy or reorganization proceedings?
YES (____) NO (____)

- I. Has the Proposer ever had any claims, judgments, or lawsuits against the City or CDM Smith Inc.?
YES (____) NO (____)

Attachment B

STATEMENT OF EXPERIENCE

(To be returned with the Proposal)

Using the summary format included below, list and describe Proposer’s construction experience for a minimum of three (3) successfully completed projects of comparable size, scope (at least two projects must be at an operational wastewater treatment plant), and complexity to the Work described in the Contract Documents. The Proposer must have completed the projects within the past Ten (10) years. Part 3 of this section outlines the experience requirements which must be demonstrated with the three (3) successfully completed sample projects. (Use additional sheets as deemed necessary or appropriate.)

Are any of the experience requirements outlined in Part 3 to be fulfilled by subcontracted resources? (circle one) YES / NO

NOTE: If yes, Attachment E (Statement of Experience for Proposer’s Listed Subcontractors) and Attachment J (Authentication of Post-Proposal Submittal) as well as any other required Post-Proposal forms must be submitted as a Post-Proposal Submittal as outlined in Paragraph 1.2 of Section #00400.

Water or Wastewater Treatment Plant Installation Project No. 1 - Experience

Name of Project: _____ Location: _____

OWNER’s Name and Address: _____

OWNER’s Contact Person (Print): _____ Phone/Fax No.: _____ / _____

Payment Bond (circle one) YES / NO

Performance Bond (circle one) YES / NO

Initial Contract Price: _____ Final Contract Price: _____

Contract Start Date: _____ (Date of Notice To Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of Proposer’s responsibilities, provide a short explanation of each.

Project Description and Statement of Relevance to this Contract:

Water or Wastewater Treatment Plant Installation Project No. 2 - Experience

Name of Project: _____ Location: _____

OWNER's Name and Address: _____

OWNER's Contact Person (Print): _____ Phone/Fax No.: _____/_____

Payment Bond (circle one) YES / NO

Performance Bond (circle one) YES / NO

Initial Contract Price: _____ Final Contract Price: _____

Contract Start Date: _____ (Date of Notice To Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of Proposer's responsibilities, provide a short explanation of each.

Project Description and Statement of Relevance to this Contract:

Water or Wastewater Treatment Plant Installation Project. 3 - Experience

Name of Project: _____ Location: _____

OWNER's Name and Address: _____

OWNER's Contact Person (Print): _____ Phone/Fax No.: _____/_____

Payment Bond (circle one) YES / NO

Performance Bond (circle one) YES / NO

Initial Contract Price: _____ Final Contract Price: _____

Contract Start Date: _____ (Date of Notice To Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of Proposer's responsibilities, provide a short explanation of each.

Project Description and Statement of Relevance to this Contract:

Attachment C

STATEMENT OF EXPERIENCE FOR PROPOSER’S KEY PERSONNEL

(To be returned with the Proposal)

General Contractor will provide an Organization Chart of all staff committed to delivering this project with a summary table for each individual that indicates: total years of experience, years of experience with the firm, years of experience in the current role, percent of time on the project site, and percent of time committed to the project. General Contractor will also provide information on the team’s bench strength in the event of loss of key personnel assigned to the project.

Attach resumes for the following personnel who will be assigned to this project. The resumes must demonstrate that these individuals have worked on at least three similar, successfully completed projects in the position indicated, or other supervisory capacity, as applicable, during the last 10 years. The key project personnel must be committed to this project for the duration of the project and cannot be removed from the project by the contractor except with the Owner’s approval.

Principal:

Name: _____

Percent of Time Allocated to Project: _____

Percent of Time On-Site: _____

Project Manager:

Name: _____

Percent of Time Allocated to Project: _____

Percent of Time On-Site: _____

Superintendent:

Name: _____

Percent of Time Allocated to Project: _____

Percent of Time On-Site: _____

Quality Control Lead:

Name: _____

Percent of Time Allocated to Project: _____

Percent of Time On-Site: _____

Safety Officer:

Name: _____

Percent of Time Allocated to Project: _____

Percent of Time On-Site: _____

Insert Resumes (No More than 2 pages per person) & Experience

Attachment D
STATEMENT OF EXPERIENCE FOR PROPOSER'S MAJOR SUBCONTRACTORS
(To be returned with the Proposal)

Name of Proposer: _____

Proposer must supply the following project history information for each major Subcontractor included for the Work. OWNER may reject any Subcontractor whose project history information OWNER deems insufficient for the task. Proposer must answer all questions completely and all information must be clear, accurate and comprehensive. If necessary, questions may be answered on separate attached sheets. Use multiple copies of Attachment E to ensure a submittal for every Major Subcontractor.

Major Subcontractor's type of work: _____

Name of Major Subcontractor: _____

Subcontractor's Permanent Address: _____

Subcontractor's Phone No.: _____

Number of years in business under current company name: _____

Project No. 1 - Major Subcontractor's Experience Information

Name of Project: _____ Location: _____

OWNER's Name and Address: _____

OWNER's Contact Person (Print): _____ Phone No.: _____

Project Description and Statement of Relevance to this Contract: _____

_____ Subcontract Price: _____

Contract Start Date: _____ (Date of Notice To Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of subcontract responsibilities, provide a short explanation of each.

Project No. 2 - Major Subcontractor's Experience Information

Name of Project: _____ Location: _____

OWNER's Name and Address: _____

OWNER's Contact Person (Print): _____ Phone No.: _____

Project Description and Statement of Relevance to this Contract: _____

_____ Subcontract Price: _____

Contract Start Date: _____ (Date of Notice to Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of subcontract responsibilities, provide a short explanation of each.

Project No. 3 - Major Subcontractor's Experience Information

Name of Project: _____ Location: _____

OWNER's Name and Address: _____

OWNER's Contact Person (Print): _____ Phone No.: _____

Project Description and Statement of Relevance to this Contract: _____

_____ Subcontract Price: _____

Contract Start Date: _____ (Date of Notice to Proceed)

Contract Time: _____ () Calendar Days () Working Days

Contract Substantial Completion Date: _____

Actual Substantial Completion Date: _____

If contract completion time extensions were added to the contract as a result of subcontract responsibilities, provide a short explanation of each.

Attachment E

AVAILABLE EQUIPMENT LIST

(To be returned with the Proposal)

Provide a list of equipment that is available to the CONTRACTOR / Subcontractor(s) and specifically intended to be used on the Work under this Contract, and notification whether the equipment is owned or to be leased by the CONTRACTOR and/or Subcontractor(s).

<u>EQUIPMENT</u>	<u>OWNED OR LEASED</u>	<u>COMMITTED TO ANOTHER PROJECT?</u> <i>(Yes / No)</i>	<u>AVAILABLE / RELEASE DATE</u>

Use additional pages, as necessary

Attachment F

AVAILABLE WORKFORCE

(To be returned with the Proposal)

Provide a list of the available workforce for the various disciplines and crafts required for the Work on this project including the number of work crews, and number and worker classification for each equipment operator, mechanic and laborer for that portion of the Work that Proposer will actually perform.

Number of Anticipated Work Crews: _____

<u>DISCIPLINE OR CRAFT</u>	<u>NO. OF EMPLOYEES</u>	<u>COMMITTED TO ANOTHER PROJECT?</u> (Yes / No)	<u>AVAILABLE / RELEASE DATE</u>
Professional (specify)			
Superintendent			
Technical (specify)			
Skilled Workers (specify)			
Semiskilled Workers (specify)			
Equipment Operators (list)			
Other			
Other			
Other			

Use additional pages, as necessary

Attachment G

CURRENT PROJECT LISTING (INCLUDING ALL CITY OF GEORGETOWN PROJECTS)

(To be returned with the Proposal)

Provide a list of **all current projects**, including **all City of Georgetown projects**. Include the following: a brief statement regarding the job type, the estimated project duration, project contact, and project description of all jobs that Proposer is currently committed to or are currently underway.

Name of Project: _____ **Location:** _____
Type of Job: _____ **City of Georgetown Job? (circle one) Yes / No**
Project Start Date: _____ **Estimated Completion Date:** _____
Project Contact: _____
Brief Description: _____

Name of Project: _____ **Location:** _____
Type of Job: _____ **City of Georgetown Job? (circle one) Yes / No**
Project Start Date: _____ **Estimated Completion Date:** _____
Project Contact: _____
Brief Description: _____

Name of Project: _____ **Location:** _____
Type of Job: _____ **City of Georgetown Job? (circle one) Yes / No**
Project Start Date: _____ **Estimated Completion Date:** _____
Project Contact: _____
Brief Description: _____

Name of Project: _____ **Location:** _____
Type of Job: _____ **City of Georgetown Job? (circle one) Yes / No**
Project Start Date: _____ **Estimated Completion Date:** _____
Project Contact: _____
Brief Description: _____

Use additional pages, as necessary

Attachment H

PROJECT HISTORY LISTING (INCLUDING ALL CITY OF Georgetown PROJECTS)

(To be returned with the Proposal)

Provide a list of **all completed projects**, including **all Public projects**. Include the following: a brief statement regarding the job type, the estimated project duration, project contact, and project description of the jobs that Proposer has completed in the past Ten (10) years by calendar year or life of company if less than Ten (10) years.

Calendar Year of _____

Name of Project: _____ **Location:** _____

Type of Job: _____ City of Georgetown Job? (circle one) Yes / No

Project Duration: _____ Project Contact: _____

Brief Description: _____

Name of Project: _____ **Location:** _____

Type of Job: _____ City of Georgetown Job? (circle one) Yes / No

Project Duration: _____ Project Contact: _____

Brief Description: _____

Name of Project: _____ **Location:** _____

Type of Job: _____ City of Georgetown Job? (circle one) Yes / No

Project Duration: _____ Project Contact: _____

Brief Description: _____

Name of Project: _____ **Location:** _____

Type of Job: _____ City of Georgetown Job? (circle one) Yes / No

Project Duration: _____ Project Contact: _____

Brief Description: _____

Use additional pages as necessary to achieve a representative listing covering 10 years

Attachment I

AUTHENTICATION OF PROPOSAL SUBMITTAL

(To be returned with the Proposal)

The Proposer must authenticate and acknowledge the preceding information by providing witness in the presence of a notary public duly licensed and authorized to act in that capacity under the laws and statutes of the State of Texas, on the form provided on the following page.

NOTARIZE ONLY THE LAST PAGE OF THIS FORM

Signed By: _____

Typed Name: _____

Typed Title: _____

Limited Partnership Acknowledgement

State of Texas

County of _____

Before me _____ (insert Notary's name), a Notary Public, on this day personally appeared _____ (insert name of person signing on behalf of general partner of limited partnership), _____, title of officer or manager and _____, name of corporation or LLC); the General Partner of _____ (insert name of limited partnership), known to me personally or on the basis of legally sufficient identification to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he or she executed the same for the purposes and consideration therein expressed.

[Seal] Given under my hand and seal of office this ____ day of _____, A.D., 20____.

Notary Public, State of Texas

Signed By: _____

Typed Name: _____

Typed Title: _____

Corporation or Limited Liability Company Acknowledgement

State of Texas

County of _____

Before me _____ (insert Notary’s name), a Notary Public, on this day personally appeared _____ (insert name of person signing on behalf of corporation or LLC) as _____ (title of officer or manager and name of corporation or LLC); known to me personally or on the basis of legally sufficient identification to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he or she executed the same for the purposes and consideration therein expressed.

[Seal] Given under my hand and seal of office this ____day of _____, A.D., 20_____.

Notary Public, State of Texas

EXHIBIT 00410
PROPOSAL BOND

PROPOSER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):
City of Georgetown
808 Martin Luther King, Jr. St.
Georgetown, Williamson County, Texas 78626

RFP NO.: 202305
RFP DUE DATE: 2 pm, March 30, 2023
PROJECT: San Gabriel WWTP Rehabilitation
PROJECT NO.: PRJ000165

BOND

BOND NUMBER:

DATE (Not later than Proposal due date):

PENAL SUM:

(Words)

(Figures)

IN WITNESS WHEREOF, Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER

SURETY

_____(Seal)

_____(Seal)

Bidder's Name and Corporate Seal

Surety's Name and Corporate Seal

By: _____
Signature and Title

By: _____
Signature and Title
(Attach Power of Attorney)

Attest: _____
Signature and Title

Attest: _____
Signature and Title

-
- Note: (1) Above addresses are to be used for giving required notice.
(2) Any singular reference to Bidder, Surety, OWNER or other party shall be considered plural where applicable.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to pay to OWNER upon default of Bidder the penal sum set forth on the face of this Bond.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by OWNER) the executed Agreement required by the Bidding Documents and any Performance and Payment Bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1. OWNER accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by OWNER) the executed Agreement required by the Bidding Documents and any Performance and Payment Bonds required by the Bidding Documents, or

3.2. All Bids are rejected by OWNER, or

3.3. OWNER fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by paragraph 5 hereof).

4. 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, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of and any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by OWNER and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 90 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier or by United States Registered or Certified Mail, return receipt requested,

postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power or Attorney evidencing the authority of the officer, agent or representative who executed this Bond on behalf of Surety to execute, seal and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer or proposal as applicable.

EXHIBIT 00500
TERMS OF AGREEMENT

The Standard Form of Agreement, General Conditions, and Supplementary Conditions are attached to this Exhibit 00500.

SECTION 00500
STANDARD FORM OF AGREEMENT
BETWEEN OWNER AND CONTRACTOR
FOR CONSTRUCTION CONTRACT

THIS AGREEMENT is by and between the City of Georgetown, Texas, a home-rule city and municipal corporation with principal offices located at 808 Martin Luther King, Jr. St., Georgetown, Williamson County, Texas 78626 (hereinafter called Owner) and _____ with principal offices located at _____ (hereinafter called Contractor).

Owner and Contractor hereby agree as follows:

ARTICLE 1 – WORK

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

San Gabriel WWTP Rehabilitation

ARTICLE 2 – THE PROJECT

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:

A. The project consists of furnishing, installing and providing all labor and materials required for construction of rehabilitation improvements to the 2.5 million gallons per day San Gabriel Wastewater Treatment Plant, as more fully described in the Drawings and the Summary of Work contained in Section CIP3.

2.02 The Project has been designed by: CDM Smith Inc., 9430 Research Blvd., Suite 1-200, Austin, Texas 78759 (Engineer), which is to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 3 – CONTRACT TIMES

3.01 *Time of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

3.02 *Dates for Substantial Completion and Final Payment*

A. The Work will be substantially completed as defined below:

1. Substantial Completion: 730 calendar days from Notice to Proceed.
2. Completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions in 820 calendar days from Notice to Proceed.

3.03 *Liquidated Damages*

- A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 3.01 above and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 3.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner the following amount for each calendar day that expires after the time specified in Paragraph 3.02 above for Substantial Completion until the Work is substantially complete: \$700.00 per each calendar day. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner \$500.00 for each calendar day that expires after the time specified in Paragraph 3.02 above for completion and readiness for final payment until the Work is completed and ready for final payment.

- 3.04 Contractor shall commence performance of the Work on the date when the Contract Times commence to run.

ARTICLE 4 – CONTRACT PRICE

- 4.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A below:

- A. For all Work, at the prices stated in Contractor’s Bid, shown below:

\$

(FIGURES)

(WRITTEN)

- 4.02 Owner agrees to pay Contractor from available funds for satisfactory performance of this Agreement in accordance with Contract Documents, and Owner agrees to make payment on account thereof as provided in the Contract Documents. Lack of funds shall render this Agreement null and void to the extent funds are not available.

ARTICLE 5 – PAYMENT PROCEDURES

5.01 *Submittal and Processing of Payments*

- A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

5.02 *Progress Payments; Retainage*

- A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the **Third Monday** of each month during performance of the Work as provided in Paragraph 6.02.A.1 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements.
1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions.
- a. **95** percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and
- b. **95** percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
- B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 100 percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

5.03 *Final Payment*

- A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07.

ARTICLE 6 – INTEREST

- 6.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest as provided in Tex. Gov. Code Chapter 2251.

ARTICLE 7 – CONTRACTOR'S REPRESENTATIONS

- 7.01 In order to induce Owner to enter into this Agreement, 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 and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities), if any, that have been identified in Paragraph 4.02 of the General Conditions as containing reliable "technical data," and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.
- E. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, 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, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents; and (3) Contractor's safety precautions and programs.
- F. Based on the information and observations referred to in Paragraph 8.01.E above, Contractor does not consider that 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.
- G. 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.
- H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
- I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 8 – CONTRACT DOCUMENTS

8.01 *Contents*

- A. The Contract Documents consist of the following:
 - 1. This Agreement (pages 1 to 8, inclusive).
 - 2. Performance bond (pages 1 to 2, inclusive).
 - 3. Payment bond (pages 1 to 2, inclusive).

4. Bid bonds (pages 1 to 2, inclusive).
 5. Certificate of Insurance
 6. Form 1295
 7. General Conditions (pages 1 to 49, inclusive).
 8. Supplementary Conditions (pages 1 to 13, inclusive).
 9. Specifications as listed in the table of contents of the Project Manual.
 10. Drawings consisting of 186 sheets with each sheet bearing the following general title: San Gabriel WWTP Rehabilitation.
 11. Addenda (numbers 1-4, inclusive).
 12. Exhibits to this Agreement (enumerated as follows):
 - a. Contractor's Proposal Form (pages 00300-1 to 00300-12, inclusive).
 - b. Documentation submitted by Contractor prior to Notice of Award (pages 1 to 2, inclusive).
 - c. Section 00100 Request for Proposals (pages 1 to 42, inclusive).
 13. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
 - a. Notice to Proceed (pages 1 to 2, inclusive).
 - b. Work Change Directives.
 - c. Change Orders.
 - d. Written Amendments.
- B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 9.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.
- E. To the extent of any direct conflict or inconsistency between any of the Contract Documents, the Contractor shall immediately seek clarification from the Engineer and notify the Owner that clarification has been requested. The Engineer shall clarify such discrepancy, within a reasonable time under the circumstances.

ARTICLE 9 – MISCELLANEOUS

9.01 *Terms*

- A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

9.02 *Assignment of Contract*

- A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are 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 Documents.

9.03 *Successors and Assigns*

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

9.04 *Severability*

- A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall 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.

9.05 *Contractor's Certifications*

- A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 10.05:
 - 1. “corrupt practice” means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process or in the Contract execution;
 - 2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
 - 3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

- 4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

9.06 *Waiver of Breach*

A. Waiver of any breach of this Agreement shall not constitute waiver of any subsequent breach.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement. Counterparts have been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or have been identified by Owner and Contractor or on their behalf.

This Agreement will be effective on _____ (which is the Effective Date of the Agreement).

OWNER:

CONTRACTOR

City of Georgetown _____

By: _____

By: _____

Title: Josh Schroeder, Mayor

Title: _____

Attest: _____

Title: City Secretary

Address for giving notices:

Address for giving notices:

City of Georgetown, Purchasing Department

510 W. 9th Street

Georgetown, TX 78626



APPROVED AS TO FORM:

City Attorney

Notice of Award

Date: _____

Project: San Gabriel WWTP Rehabilitation

Owner: City of Georgetown

Owner's Contract No.: 23-0041-CIP

Project Nos.: PRJ000165

Engineer's Project No.: 264953

Proposer:

Proposer's Address:

You are notified that your Proposal dated _____ for the above Contract has been considered. You are the Successful Proposer and are awarded a Contract for San Gabriel WWTP Rehabilitation.

The project consists of furnishing, installing and providing all labor and materials required for construction of rehabilitation improvements to the 2.5 million gallon per day San Gabriel Wastewater Treatment Plant, as more fully described in the Drawings and the summary of work contained in Section CIP3.

The Contract Price of your Contract is _____ Dollars (\$ _____)

(3) copies of the proposed Contract Documents (except Drawings) accompanied the Notice of Impending Award.

Sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 15 days of the date you receive this Notice of Award, if you have not already.

1. Deliver to the Owner 3 fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20), General Conditions (Paragraph 5.01), and Supplementary Conditions (Paragraph SC-5.01).

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Proposal security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

City of Georgetown

Owner

By: _____
Authorized Signature

CIP Manager

Title

Copy to Engineer

This page intentionally left blank.

Notice to Proceed

Date: _____

Project: San Gabriel WWTP Rehabilitation

Owner: City of Georgetown

Owner's Contract No.: 23-0041-CIP

Project Nos.: PRJ000165

Engineer's Project No.: 264953

Contractor:

Contractor's Address:

You are notified that the Contract Times under the above Contract will commence to run on _____. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the Work will be substantially completed 730 calendar days from Notice to Proceed; and, the Work will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions 820 calendar days from Notice to Proceed.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds and loss payees) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must:

1. Submit and receive approval on the construction sequence and schedule of values.
2. Hold the pre-construction meeting.

City of Georgetown

Owner

Given By:

Authorized Signature

CIP Manager

Title

Date

Copy to Engineer

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SECTION 00610
TEXAS STATUTORY PERFORMANCE BOND

Bond No.:

KNOW ALL MEN BY THESE PRESENTS:

THAT, _____(hereinafter called the Principal, and _____, a corporation organized and existing under the laws of the State of Texas, licensed to do business in the State of Texas and admitted to write bonds, as surety, (hereinafter called the Surety), are held and firmly bound unto the City of Georgetown, Texas (hereinafter called the Obligee), in the amount of _____Dollars (\$_____) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain contract with the Obligee, dated the _____day of _____,2023 for San Gabriel WWTP Rehabilitation, which contract is hereinafter referred to as the "Contract."

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform the work required by the Contract and shall, in all respects, duly and faithfully observe and perform all and singular the covenants, conditions and agreements in and by said Contract, agreed and covenanted by the Principal to be observed and performed, including but not limited to, the repair of any and all defects in said work occasioned by and resulting from defects in materials furnished by or workmanship of, the Principal in performing the work covered by said Contract and occurring within a period of twelve (12) months from the date of Final Completion and all other covenants and conditions, according to the true intent and meaning of said Contract and the Plans and Specifications hereto annexed, then this obligation shall be void; otherwise to remain in full force and effect;

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code and all liabilities on this bond shall be determined in accordance with the provision, conditions and limitations of said Chapter to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____day of _____, 2023.

Principal

Surety

Printed Name

Printed Name

By: _____
Title: _____
Address: _____

By: _____
Title: _____
Address: _____

Resident Agent of Surety:

Signature

Printed Name

Street Address

City, State & Zip Code

SECTION 00620
TEXAS STATUTORY PAYMENT BOND

Bond No.:

KNOW ALL MEN BY THESE PRESENTS:

THAT, _____ (hereinafter called the Principal), as principal, and _____, a corporation organized and existing under the laws of the State of Texas, licensed to do business in the State of Texas and admitted to write bonds, as surety, (hereinafter called the Surety), are held and firmly bound unto the City of Georgetown, Texas (hereinafter called the Obligee), in the amount of _____ Dollars (\$_____) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain contract with the Obligee, dated the _____ day of _____, 2023 for San Gabriel WWTP Rehabilitation, which contract is hereinafter referred to as the "Contract."

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall pay all claimants supplying labor and material to him or a subcontractor in the prosecution of the work provided for in said Contract, then, this obligation shall be null and void; otherwise to remain in full force and effect;

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code and all liabilities on this bond shall be determined in accordance with the provision, conditions and limitations of said Chapter to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 2023.

Principal

Surety

Printed Name

Printed Name

By: _____

By: _____

Title: _____

Title: _____

Address: _____

Address: _____

Resident Agent of Surety:

Signature

Printed Name

Street Address

City, State & Zip Code

SECTION 00650
Certificate of Insurance

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SECTION 00680

Form 1295

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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the Controlling Law.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly By



PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
a practice division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

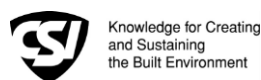
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Construction Specifications Institute

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American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor Nos. C-520 or C-525 (2002 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the EJCDC Construction Documents, General and Instructions (No. C-001) (2002 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (No. C-800) (2002 Edition).

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GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Proposal Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*--Written or graphic instruments issued prior to the opening of Proposals which clarify, correct, or change the Proposal Requirements or the proposed Contract Documents. In case of inconsistency between the Contract Documents and any Addenda, the Addenda supersede other Contract Documents.

2. *Agreement*--The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*--The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*--Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Proposal*--The offer or proposal of an Offeror submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Offeror*--The individual or entity who submits a Proposal directly to Owner.

7. *Proposal Documents*--The Proposal Requirements and the proposed Contract Documents (including all Addenda).

8. *Proposal Requirements*--The Advertisement or Request for Proposal, Instructions to Offerors, security of acceptable form, if any, and the Proposal Form with any supplements.

9. *Change Order*--A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract

Times, issued on or after the Effective Date of the Agreement. Extra Work will not be considered for a Change Order or for an adjustment in the Contract Price or the Contract Times unless the document is executed by both Owner and Contractor. Furthermore, the parties agree that under no circumstances will an act or failure to act on the part of the Owner or the Engineer constitute a waiver of the written Change Order requirement for extra work. A written Change Order is a strict condition precedent for payment of extra work.

10. *Claim*--A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*--The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral including, without limitation, all prior iterations of these General Conditions, the Supplementary Conditions, or any other document not specifically listed in the Agreement.

12. *Contract Documents*-- The Contract Documents consist of the Agreement between Owner and Contractor, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Work Change Directive or (4) a Field Order. Unless specifically enumerated in the Agreement, the Contract Documents do not include other documents such as proposal requirements (advertisement or Request for Proposal, Instructions to Proposers, sample forms, the Contractor's Proposal, portions of Addenda relating to proposal requirements), Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions.

13. *Contract Price*--The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*--The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*--The individual or entity with whom Owner has entered into the Agreement. For

purposes of giving or receiving notice, directives, change orders, or any other information from the Engineer or Owner to the Contractor, the Contractor shall designate one person as Project Manager to receive such notice, directives, change orders, or other information. If the person so identified by the Contractor is not present on the job site during normal working hours for any consecutive 48-hour period, the Contractor shall in writing addressed to the Engineer and Owner identify the individual who is acting as Project Manager.

16. *Cost of the Work*--See Paragraph 11.01.A for definition.

17. *Drawings*--That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver. However, Contractor has no rights or remedies arising from execution of the Agreement prior to receiving a Notice to Proceed from Owner or Engineer.

19. *Engineer*--The individual or entity named as such in the Agreement. The Engineer shall identify a specific individual to serve as liaison between the Owner and Contractor and between Engineer and Contractor. The Engineer will notify the Owner and Contractor of the name of an acting replacement as Engineer representative whenever the person so designated is not available. Whenever the Contractor or Owner requires information, direction, or assistance, the Contractor or Owner shall notify the individual designated by the Engineer.

20. *Field Order*--A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times. The Engineer will promptly obtain the signature of the Contractor on all Field Orders. This signature confirms that the Contractor is not entitled to any change in the Contract Price or the Contract Times. The Engineer will endeavor to obtain the signature of the Contractor on all Field Orders on a weekly basis.

21. *General Requirements*--Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

22. *Hazardous Environmental Condition*--The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

23. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. *Laws and Regulations; Laws or Regulations*--Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. *Liens*--Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*--The written notice by Owner to the Successful Offeror stating that upon timely compliance by the Successful Offeror with the conditions precedent listed therein, Owner, if the Owner decides to proceed with the Work, will sign and deliver the Agreement, to the apparent successful Offeror. However, the Notice of Award shall not be construed as an agreement, meeting of the minds, contract, or any other legal obligation between Owner and Contractor. Until Contractor receives a Notice to Proceed from the Owner, the Contractor has no remedy against the Owner.

28. *Notice to Proceed*--A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*--The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed. As a general matter, the Contractor should utilize the Engineer's designated representative as the liaison between the Contractor and the Owner. However, in an exceptional circumstance, the Contractor can notify Owner's designated representative.

30. *PCBs*--Polychlorinated biphenyls.

31. *Petroleum*--Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *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.

33. *Project*--The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*--The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *Radioactive Material*--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. *Related Entity* -- An officer, director, partner, employee, agent, consultant, or subcontractor.

37. *Resident Project Representative*--The authorized representative of Engineer who may be assigned to the Site or any part thereof.

38. *Samples*--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

39. *Schedule of Submittals*--A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

40. *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 reviewing Contractor's Applications for Payment.

41. *Shop Drawings*--All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

42. *Site*--Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

43. *Specifications*--That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

44. *Subcontractor*--An individual or entity having a direct contract with Contractor or with any other

Subcontractor for the performance of a part of the Work at the Site.

45. *Substantial Completion*--The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Owner, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

46. *Successful Offeror*--The Offeror submitting a responsive Proposal to whom Owner makes an award.

47. *Supplementary Conditions*--That part of the Contract Documents which amends or supplements these General Conditions.

48. *Supplier*--A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or any Subcontractor.

49. *Underground Facilities*--All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

50. *Unit Price Work*--Work to be paid for on the basis of unit prices.

51. *Work*--The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

52. *Work Change Directive*--A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The following words or terms are not defined but, when used in the Proposal Requirements or Contract Documents, have the following meaning.

B. *Intent of Certain Terms or Adjectives*

1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day*

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:

- a. does not conform to the Contract Documents,
- or
- b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents, or

c. has been damaged prior to Engineer’s - recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor shall each deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which Owner or any additional insured may reasonably request) which Contractor is required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to four (4) printed or hard copies of the Drawings and Project

Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

A. TIME IS OF THE ESSENCE OF THIS CONTRACT. This is a Calendar Day Contract. The Contract Times will commence to run on the day indicated in the Notice to Proceed. The Owner will provide a Notice to Proceed at a reasonable time after the effective date of the Agreement. In no event will the Owner have any obligations or duties to the Contractor under the Agreement until the Notice to Proceed is given to the Contractor.

2.04 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run as set forth in the Notice to Proceed. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Owner and Engineer for timely review:

1. a preliminary Progress Schedule; indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious, economical, and practicable execution of the Work. The Contractor shall perform all Work in accordance with the most recent Progress Schedule submitted to the Owner and Engineer. Nothing contained herein will impose on Owner or Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

a. The Progress Schedule shall be in a detailed precedence-style critical path method ("CPM") or primavera-type format satisfactory to the Owner. The Progress Schedule shall also (i) provide a graphic representation of all activities and events that will occur during performance of the Work; (ii) identify each phase of construction and occupancy; and (iii) set forth dates that are critical in ensuring the timely and orderly completion of the Work in accordance with the requirements of the Contract Documents (hereinafter referred to as "Milestone Dates"). Upon review and acceptance by the Owner of the Milestone Dates, the Progress Schedule shall be deemed part of the Contract Documents. If not accepted, the Progress Schedule shall be promptly revised by Contractor in accordance with the recommendations of the Owner and resubmitted for acceptance. The Contractor shall monitor the progress of the Work for conformance with the requirements of the Progress Schedule and shall promptly advise the Owner of any delays or potential delays. The accepted Progress Schedule shall be updated to reflect the actual conditions as set forth in Paragraph 2.6.1 or if requested by either the Owner or the Engineer.

b. The parties acknowledge and agree that notwithstanding any theoretical delays or theoretical extensions of time for completion as may be shown on the Progress Schedule, the Interim Completion Dates, Milestone Dates, and the Scheduled Completion Date shall be governed by the Contract and shall be extended only in accordance with the procedures set forth in the Contract Documents.

c. In the event that the Owner or Engineer determines that the Work has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation, (i) working additional shifts or overtime, (ii) supplying additional manpower, equipment, and facilities, and (iii) other similar measures. Contractor agrees to take such corrective measures to expedite the progress of construction until the progress of the Work complies with the state of completion required by the Contract Documents.

d. In the event Owner or Engineer determines that Contractor is not timely performing any of its Work or that Contractor is not keeping up with the Progress Schedule, Owner may, in addition to Owner's rights stated herein, request Contractor to prepare a Recovery Schedule. In such event, Contractor will prepare a Recovery Schedule in such form and in such detail as Owner may request. Contractor further agrees that it will work as necessary to meet the requirements of the Recovery Schedule and bring its Work into compliance with the current Progress Schedule (all without any additional cost to Owner). No approval by Owner or Engineer of Contractor's Recovery Schedule pursuant to this Paragraph shall constitute a waiver by Owner of any damages or losses which Owner may suffer as a result of Contractor's failure to meet the Scheduled Completion Date.

2. Contractor's Schedule of Submittals will be acceptable to Owner and Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Owner and Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

4. If required by Owner, Contractor shall also prepare and furnish project cash flow projections, manning charts for all key trades, and schedules for the purchase and delivery of all equipment and materials, together with the periodic updating thereof.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT,
AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or

equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

D. In the event of inconsistencies within or between the parts of the Contract Documents, or between the Contract Documents and applicable standards, codes, or ordinances, the Contractor shall (i) provide the better quality or greater quantity of Work or (ii) comply with the more stringent requirement; either or both in accordance with the Engineer's interpretation.

3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Proposals (or on the Effective Date of the Agreement if there were no Proposals), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Engineer, or any of, their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. Reporting Discrepancies

1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Owner and Engineer any conflict, error, ambiguity, or discrepancy which Contractor may discover in the Contract Documents, or any condition at the site affecting the Work, and shall obtain a written interpretation or clarification from Owner and Engineer before proceeding

with any Work affected thereby. The Contractor shall be liable to the Owner for failure to report any conflict, error, ambiguity or discrepancy in the Contract Documents which the Contractor knew or reasonably should have known.

2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to Owner and Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor knew or reasonably should have known thereof.

4. The terms "knowledge," "recognize," and "discover," their respective derivatives, and similar terms in the Contract Documents, as used in reference to the Contractor, shall be interpreted to mean that which the Contractor knows (or should know), recognizes (or should recognize), and discovers (or should discover) in exercising the care, skill, and diligence required by the Contract Documents. Analogously, the expression "reasonably inferable" and similar terms in the Contract Documents shall be interpreted to mean reasonably inferable by a contractor familiar with the Project and exercising the care, skill, and diligence required of the Contractor by the Contract Documents.

B. Resolving Discrepancies

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work can only be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample; (Subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

Any variations and deviations in the Work arising from any of the methods set forth in Paragraph 3.04.B will not authorize any Amendments to the Contract Price or Contract Times. The sole method to amend the Contract Price or Contract Times is pursuant to Paragraph 3.04.A.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier or other individual or entity performing or furnishing all of the Work under a direct or indirect contract with Contractor, shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or Engineer's consultants, including electronic media editions; or

2. reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaption by Engineer.

B. The prohibition of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Copies of data furnished by Owner or Engineer to Contractor or Contractor to Owner or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 - AVAILABILITY OF LANDS;
SUBSURFACE AND PHYSICAL CONDITIONS;
HAZARDOUS ENVIRONMENTAL CONDITIONS;
REFERENCE POINTS

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Contract Documents; and

2. those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Contract Documents.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. The Contractor hereby covenants that it has examined the site of the proposed Work and is familiar with all of the conditions surrounding construction of the Project, having conducted all inquiries, tests and investigations for the Work.

1. The Contractor acknowledges that he has satisfied himself as to the nature and location of the Work; the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the Work and all other matters which can in any way affect the work or the cost thereof under this Contract.

2. The Contractor further acknowledges that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be

encountered from inspecting the Site and from evaluating information derived from exploratory work, if any, that has been presented in any geotechnical report, as well as from information presented in the Supplementary Conditions. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the Work. Neither the Owner nor the Engineer assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the Owner or the Engineer. All risks of differing site conditions shall be borne solely by the Contractor.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all such information and data,

b. locating all Underground Facilities shown or indicated in the Contract Documents and notifying Texas One Call Service,

c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction, and

d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

3. Notwithstanding any other provision to the contrary, the Contractor shall be solely responsible for the location and protection of any and all public lines and utility customer service lines in the Work area. For the purposes of this section, "public lines" means the utility distribution and supply system within public rights-of-way or easements, and "utility customer service lines" (service) means any utility line connecting a utility customer to the utility distribution system. Generally, existing service connections within right-of-way or easements are not shown on the Drawings. The

Contractor shall notify the Owner and "Texas One Call Service" and exercise due care to locate and to mark, uncover or otherwise protect all such lines in the construction zone and any of the Contractor's work or storage areas. The Contractor's obligation hereunder shall be primary and non-delegable. **The Contractor shall indemnify or reimburse such expenses or costs (including fines that may be levied against the Owner) that may result from unauthorized or accidental damage to all public lines and utility customer service lines in the Work area.** The Owner reserves the right to repair such damage the Contractor may cause, at the Contractor's expense.

B. *Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, within 24 hours after the Contractor discovers and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

C. The Contractor shall take reasonable precaution to avoid disturbing primitive records and antiquities of archaeological, paleontological or historical significance. No objects of this nature shall be disturbed without written permission of the Owner and the Texas Department of Antiquities Protection. When such objects are uncovered unexpectedly, the Contractor shall stop all Work in close proximity and notify Owner's Representative and the Texas Department of Antiquities Protection of their presence and shall not disturb them until written permission and permit to do so is granted. All primitive rights and antiquities uncovered on the Owner's property shall remain property of the State of Texas, the Texas Department of Antiquities Protection conforming to the Texas Natural Resources Code. If it is determined by the Owner, in consultation with the Texas Department of Antiquities Protection, that exploration or excavation of primitive records or antiquities on Project site is necessary to avoid loss, the Contractor shall cooperate in salvage work attendant to preservation. If the Work stoppage or salvage work causes an increase in the Contractor's cost of, or time required for, performance of the Work, the Contract Amount and/or Contract Time may be equitably adjusted.

4.05 *Reference Points*

A. Engineer shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior

written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by a Registered Professional Land Surveyor at Contractor's expense.

4.06 *Hazardous Environmental Condition at Site*

A. Reports and Drawings: Reference is made to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the Engineer in the preparation of the Contract Documents.

B. Limited Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

C. The Contractor must take all precautions to discovery and locate any Hazardous Environmental Condition(s) at the site that may present a substantial danger to persons or property exposed thereto in connection with the Work at the site. The Contractor is responsible for any damages caused by such Hazardous Environmental Condition(s) created on the site by a Contractor, Subcontractor, Supplier, or anyone else for whom the Contractor is responsible. Within 24 hours of the time when the Contractor discovers the Hazardous Environmental Condition(s), the Contractor will follow the procedures set forth in Paragraph 4.06.D.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all

Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered to Contractor written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

5.01 Performance, Payment, and Other Bonds

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 Licensed Sureties and Insurers

A. All bonds and insurance required by the Contract Documents shall be obtained from solvent surety or insurance companies that are duly licensed by the State of Texas and authorized to issue bonds or insurance policies for the limits and coverages required by the Contract Documents. The bonds shall be in a form acceptable to the Owner and shall be issued by a surety which complies with the requirements of Art. 7.19-1, Texas Insurance Code and which is otherwise acceptable to the Owner. Owner may require the surety to obtain reinsurance for any portion of the risk that exceeds 10% of the surety's capital and surplus. For bonds exceeding \$100,000, the surety must also hold a certificate of authority from the U.S. Secretary of the Treasury or have obtained reinsurance from a reinsurer that is authorized as a reinsurer in Texas and holds a certificate of authority from the U.S. Secretary of the Treasury.

Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 Certificates of Insurance

A. Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

5.04 Contractor's Liability Insurance

A. Contractor shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed 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:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims 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.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insured (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

6. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment.

a. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Workers' Compensation Insurance Coverage.*

A. Definitions:

Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the commission, or a coverage agreement (TWCC-81, TWCC-82, TWCC-83, or TWCC-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.

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.

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 seven 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 Workers' Compensation Commission, 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. This notice does not satisfy other posting requirements imposed by the Act or other commission rules. This notice must be printed with a title in at least 30 point bold type and text in at least 19 point normal type, and shall be in both English and Spanish and any other language common to the worker population. The text for the notices shall be the following text provided by the commission on the sample notice, without any additional words or changes:

"REQUIRED WORKERS' COMPENSATION COVERAGE"

"The law requires that each person working on this site or providing services related to this construction project must be covered by workers' compensation insurance. This includes persons providing, hauling, or delivering equipment or materials, or providing

labor or transportation or other service related to the project, regardless of the identity of their employer or status as an employee."

"Call the Texas Workers' Compensation Commission at 512-440-3789 to receive information on the legal requirement for coverage, to verify whether your employer has provided the required coverage, or to report an employer's failure to provide 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 Owner 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 commission's Division of Self-Insurance Regulation. 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 Owner to declare the Contract void if the Contractor does not remedy the breach within ten days after receipt of notice of breach from the Owner.

5.06 *Builder's Risk Insurance*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, false work, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, (other than caused by flood) and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided

that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until each of the substantial completion milestones unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. Contractor shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) in such policies and will provide primary coverage

for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insured or additional insured (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for:

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order .

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached,

Owner as fiduciary shall adjust and settle the loss with the insurers.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of

construction which is shown or indicated in and expressly required by the Contract Documents.

B. The Contractor shall have an English-speaking, competent Superintendent on the Work at all times that Work is in progress. Upon request of Owner, the Contractor shall present the resume of the proposed Superintendent to Owner showing evidence of experience and successful superintendence and direction of work of a similar scale and complexity. If, in the opinion of Owner, the proposed Superintendent does not indicate sufficient experience in line with the Work, he/she will not be allowed to be the designated Superintendent for the Work. The Superintendent shall not be replaced without Written Notice to Owner. If the Contractor deems it necessary to replace the Superintendent, the Contractor shall provide the necessary information for approval, as stated above, on the proposed new Superintendent. A qualified substitute Superintendent may be designated in the event that the designated Superintendent is temporarily away from the Work, but not to exceed a time limit acceptable to Owner. The Contractor shall replace the Superintendent upon the Owner's request in the event the Superintendent is unable to perform to the Owner's satisfaction. The Superintendent will be the Contractor's representative on the Work and shall have the authority to act on behalf of the Contractor. All communications given to the Superintendent shall be as binding as if given to the Contractor. Either the Contractor or the Superintendent shall provide an emergency and home telephone number at which one or the other may be reached if necessary when work is not in progress.

C. The Contractor agrees to employ only orderly and competent workers, skillful in performance of the type of Work required under the Contract. The Contractor, Subcontractors, Sub-subcontractors, and their employees may not use or possess any firearms, alcoholic or other intoxicating beverages, illegal drugs or controlled substances while on the job or on the Owner's property, nor may such workers be intoxicated, or under the influence of alcohol or drugs, on the job. If the Owner or Owner's Representative notifies the Contractor that any worker is incompetent, disorderly or disobedient, has knowingly or repeatedly violated safety regulations, has possessed any firearms, or has possessed or was under the influence of alcohol or drugs on the job, the Contractor shall immediately remove such worker from performing Contract Work, and may not employ such worker again on Contract Work without the Owner's prior written consent. The Contractor shall at all times maintain good discipline and order on or off the site in all matters pertaining to the Project.

6.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents.

Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. The Contractor agrees to assign to the Owner at the time of final completion of the Work any and all manufacturer's warranties relating to materials and labor used in the Work, and the Contractor further agrees to perform the Work in such manner to preserve any and all manufacturer's warranties. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

1. The Contractor shall furnish twenty-four (24) hour callback maintenance service for the equipment provided by the Contractor for a period of three (3) months after completion and acceptance of the Work. This service shall include regular examination of the equipment by competent and trained employees of the Contractor and shall include all necessary adjustments, greasing, oiling, cleaning, supplies, and parts to keep the equipment in proper operation, except parts made necessary by misuse, accident, or negligence not caused by the Contractor or any Subcontractors of any tier.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07

as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole,

3) it has a proven record of performance and availability of responsive service; and

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times, and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. Substitute Items

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services;

4) and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change,

B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. Engineer's Evaluation: Engineer will be allowed seven (7) days within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

D. Special Guarantee: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. Engineer's Cost Reimbursement: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute item so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Engineer for making changes in the Contract

Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. Contractor's Expense: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 Concerning Subcontractors, Suppliers, and Others

A. Not later than 14 days after the execution of the Agreement by the Contractor and Owner, the Contractor shall furnish the Owner and the Engineer, in writing, with (1) the name, trade, and subcontract amount for each Subcontractor and (2) the names of all persons or entities proposed as manufacturers of the products identified in the Specifications (including those who are to furnish materials or equipment fabricated to a special design) and, where applicable, the name of the installing Subcontractor. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Proposal Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any

contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity, nor

2. shall anything in the Contract Documents create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product,

or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights 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 not specified in the Contract Documents.

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Proposals, or, if there are no Proposals, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations. The Contractor shall plan and execute its operations in compliance with all applicable Federal, State and local laws and regulations, including those concerning control and abatement of water pollution and prevention and control of air pollution. The Contractor shall conduct activities in compliance with applicable laws and regulations and other requirements of the Contract relating to the environment, and its protection at all times. Unless otherwise specifically determined, the Contractor is responsible for obtaining and maintaining permits related to storm water run-off. The Contractor shall conduct operations consistent with storm water run-off permit conditions.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or

Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work.

C. Changes in Laws or Regulations not known at the time of opening of Proposals (or, on the Effective Date of the Agreement if there were no Proposals) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 Taxes

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

B. The Owner is an exempt organization as defined by Chapter 11 of the Property Tax Code of Texas and is thereby exempt from payment of Sales Tax under Chapter 151, Limited Use Sales, Excise and Use Tax, Texas Tax Code, and Article 1066 (C), Local Sales and Use Tax Act, Revised Civil Statutes of Texas. The Owner may issue a "Texas Sales and Use Tax Exemption Certification" authorizing the Contractor to use same in the purchase of materials for the Project.

6.11 Use of Site and Other Areas

A. Limitation on Use of Site and Other Areas

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not

limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 Record Documents

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

B. The Record Documents shall be updated to show the "As-Constructed" Drawings and Specifications monthly prior to submission of periodic Applications for Payment. Failure to update the "As-Constructed" Drawings and Specifications constitutes cause for denial of a progress payment otherwise due.

C. Upon Substantial Completion of the Work, these record documents, samples and Shop Drawings shall be promptly delivered to Owner. Prior to requesting a Substantial Completion inspection, Contractor shall furnish a complete set of the marked up "As-Constructed" Drawings and Specifications and one copy of same. Concurrently, Contractor shall submit a preliminary copy of each operating and maintenance manual required by the Contract Documents for review by the Owner and

Engineer. Once determined acceptable, Contractor shall provide Mylar prints of professionally drafted "As Constructed" Drawings and Specifications in bound volumes along with electronic copies on CD in a format acceptable to Owner, two (2) sets of photocopies of the Mylar prints, two sets of operating and maintenance manuals, two sets of approved submittals, and any other record documents required by the Contract Documents.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or , or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

D. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has

issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

E. When the Work requires excavation which either exceed four (4) feet in depth or results in any worker's upper body being positioned below grade level, the Contractor is required to submit a trenching plan to the Owner prior to commencing trenching operations. The plan is required to be prepared and sealed by a professional engineer registered in the State of Texas, and employed by the Contractor. Said engineer cannot be anyone who is otherwise engaged directly or indirectly with this Project.

F. The Contractor shall erect and maintain, as required by existing conditions and performance of the Contractor, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent sites and utilities.

G. When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer written notice immediately, and in no instance more than 24 hours after the alleged emergency, if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by

Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the acceptable Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. Shop Drawings

a. Submit number of copies specified in the General Requirements.

b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples*: Contractor shall also submit Samples to Engineer for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals.

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. Submittal Procedures

1. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

b. the suitability of all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;

c. all information relative to Contractor's responsibilities for means, methods, techniques, sequences,

and procedures of construction, and safety precautions and programs incident thereto; and

d. shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations, that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample Submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. Engineer's Review

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals 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. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. Resubmittal Procedures

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

6.20 *Indemnification*

A. CONTRACTOR SHALL INDEMNIFY AND HOLD OWNER HARMLESS AGAINST ANY LOSS OR DAMAGE TO PERSONS OR PROPERTY AS A RESULT OF OPERATIONS GROWING OUT OF THE PERFORMANCE OF THIS CONTRACT AND CAUSED BY THE NEGLIGENCE OR CARELESSNESS OF CONTRACTOR, CONTRACTOR'S EMPLOYEES, SUBCONTRACTORS, AND AGENTS OR LICENSEES. THE CONTRACTOR SHALL UNCONDITIONALLY DEFEND AT ITS OWN COST AND SHALL INDEMNIFY AND HOLD HARMLESS THE OWNER, ENGINEER, ENGINEER'S CONSULTANTS AND SUBCONSULTANTS AND THEIR RESPECTIVE OFFICERS, DIRECTORS, PARTNERS, EMPLOYEES, AGENTS AND OTHER CONSULTANTS AND ANY OF THEM FROM AND AGAINST ALL CLAIMS, JUDGMENTS, COSTS, LIENS, LIABILITIES, LOSSES, DAMAGES, PENALTIES, INTEREST, FEES, FINES, COSTS AND EXPENSES (INCLUDING BUT NOT LIMITED TO ALL FEES AND CHARGES OF ENGINEERS, ARCHITECTS, ATTORNEYS AND OTHER PROFESSIONALS AND ALL COURT OR OTHER DISPUTE RESOLUTION COSTS) IN ANY MANNER ARISING DIRECTLY OR INDIRECTLY OUT OF, OR RESULTING FROM, THE WORK PERFORMED HEREUNDER OR THE MATERIALS TO BE FURNISHED UNDER THE CONTRACT DOCUMENTS, THAT IS:

1. ATTRIBUTABLE TO BODILY INJURY, SICKNESS, DISEASE OR DEATH (INCLUDING EMPLOYEES OF CONTRACTOR AND OWNER), OR TO INJURY TO OR DESTRUCTION OF TANGIBLE PROPERTY (INCLUDING PROPERTY OF CONTRACTOR AND OWNER AND THE WORK ITSELF), INCLUDING THE LOSS OF USE RESULTING THEREFROM, AND

2. CAUSED IN WHOLE OR IN PART BY ANY NEGLIGENT ACT, ERROR OR OMISSION; SOLE NEGLIGENCE; CONCURRENT NEGLIGENCE; JOINT NEGLIGENCE; ACTIVE OR PASSIVE NEGLIGENCE; GROSS NEGLIGENCE; NEGLIGENCE PER SE; STRICT LIABILITY; INVERSE CONDEMNATION, PATENT INFRINGEMENT; COPYRIGHT; CONDITION OF PROPERTY OR ITS PREMISES; LATENT DEFECTS; DEFECTS IN MATERIALS, WORKMANSHIP, OR DESIGN; WORKERS' COMPENSATION CLAIMS; DISABILITY ACT CLAIMS; EMPLOYEE BENEFIT CLAIMS; AND FAILURE TO COMPLY WITH ANY OF THE

**PROVISIONS OF THE CONTRACT DOCUMENTS;
OR OTHER ACT OR OMISSION OF
CONTRACTOR, OR CONTRACTOR'S
EMPLOYEES, SUBCONTRACTORS, OR AGENTS
OR LICENSEES.**

B. In any and all claims against Owner or Engineer or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such

professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 - OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or via other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
2. the specific matters to be covered by such authority and responsibility will be itemized; and
3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.

C. Contractor shall be liable to Owner and any other contractor for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's action or inactions.

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

A. Owner shall furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by Engineer in preparing the Contract Documents.

8.06 *Insurance*

A. Owner's responsibilities, if any, in respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner and Engineer.

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such

Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. The Engineer will obtain on a weekly basis the Contractor's signature on all Field Orders that will contain an acknowledgement by the Contractor that the Field Order does not involve an adjustment in the Contract Price or in the Contract Times.

9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to, the Resident Project Representative, if any, and assistants, if any.

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided). A change in the Contract Price or the Contract Times shall be accomplished only by written Amendment, a written Change Order, or a written Work Change Directive. Accordingly, no course of conduct or dealings between the parties, no expressed or implied acceptance of alterations or additions to the Work, and no claim that the Owner has been unjustly enriched by any alterations or additions to the Work shall be the basis of any claim for an increase in any amount due under the Contract Documents or a change in any time period provided for in the Contract Documents.

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change

Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

Agreements on any Change Order shall constitute a final settlement of all matters relating to the change in the Work that is the subject of a Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments to the Contract Price and the Contract Times. In the event a Change Order increases the Contract Price, the Contractor shall include the Work covered by such Change Order in Applications for Payment as if such Work were originally part of the Contract Documents.

10.04 *Notification to Surety*

A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any bond to be given to a surety, the giving of any such notice will be Contractor's responsibility. The amount of each

applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim, shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part,

2. approve the Claim, or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the

dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

G. In calculating the amount of any claim or measure of damages for breach of contract (such provision to survive any termination of following such breach), the following standards shall apply:

1. No indirect or consequential damages will be allowed;
2. No recovery shall be based on a comparison of planned expenditures to total actual expenditures, or on estimated losses of labor efficiency, or on a comparison of planned manloading to actual manloading, or any other analysis that is used to show damages indirectly;
3. Damages are limited to extra costs specifically shown to have been directly caused by a proven wrong;
4. No damages shall be allowed for delay;
5. No damages will be allowed for home office overhead or other home office charges or any Eichleay formula calculation; and
6. No profit will be allowed on any damage claim.

ARTICLE 11 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 Cost of the Work

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.01.B.

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other

personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized in writing by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to Engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work, but only to the extent authorized and approved in writing by Owner and Engineer.

5. Supplemental costs including 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. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from

Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expresses, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. Costs Excluded: The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, 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 11.01.A.1 or specifically covered by

Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

C. Contractor's Fee: When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

D. Documentation: Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

E. Pricing Information Requirements: The Contractor agrees to provide and require all Subcontractors to provide a breakdown of allowable labor and labor burden cost information as outlined herein. This information will be used to evaluate the potential cost of labor and labor burden related to Change Order Work. It is intended that this information represent an accurate estimate of the Contractor's actual labor and labor burden cost components. This information is not intended to establish fixed billing or Change Order pricing labor rates. However, at the time Change Orders are priced the submitted cost data for labor rates may be used to price Change Order Work. The accuracy of any such agreed-upon labor cost components used to price Change Orders will be subject to later audit. Approved Change Order amounts may be adjusted later to correct the impact of inaccurate labor cost components if the agreed-upon labor cost components are determined to be inaccurate.

11.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. Cash Allowances

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. 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 no demand for additional payment on account of any of the foregoing will be valid.

C. Contingency Allowance

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work 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 comparison of Proposals and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. When "plan quantity" is indicated for a proposal item, the Contractor shall be paid the amount specified in the Contract Documents without any measurements.

E. A Major Item is any individual proposal item in the Proposal that has a total cost equal to or greater than five percent (5%) of the original Contract Amount or \$50,000, whichever is greater, computed on the basis of proposal quantities and Contract unit prices.

F. The Owner or the Contractor may make a Claim for an adjustment in the Contract Amount if:

1. the actual quantity of any Major Item should become as much as twenty percent (20%) more than or twenty percent (20%) less than in the Bid; or

2. The Contractor presents proper documentation contesting the accuracy of "plan quantity," and Owner's Representative verifies quantity and determines original quantity is in error by five percent (5%) or more.

ARTICLE 12 - CHANGE OF CONTRACT PRICE;
CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order.

1. If the total of amount of all Change Orders, in the aggregate, involves a decrease or an increase of more than \$25,000, no Change Order shall be valid unless it is approved by the City Council of the City of Georgetown. The original Contract Price may not be increased by more than twenty-five percent (25%) under any circumstances and it may not be decreased more than twenty-five percent (25%) without the consent of the Contractor to such decrease.

2. Any claim for an adjustment in the Contract Amount shall be made by Written Notice delivered by the party making the Claim to the other party promptly (but in no event later than thirty (30) calendar days) after the start of the occurrence or event giving rise to the Claim and stating the general nature of the Claim, but in any case before proceeding to execute the work considered to be additional costs (except for Emergencies as described in Article 6). Notice of the amount of the Claim with supporting data shall be delivered within thirty (30) calendar days after Written Notice of Claim is delivered by claimant, and shall represent that the adjustment claimed covers all known amounts to which claimant is entitled as a result of said occurrence or event.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 10 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 10 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

C. All time limits stated in the Contract Documents are of the essence of the Agreement. The Contractor acknowledges and understands that failure by the Contractor to complete the Work in accordance with the construction schedule will cause significant damages to the Owner, and subject Contractor to Liquidated Damages as stated in the Agreement.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of Engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

F. Notwithstanding anything to the contrary in the Contract Documents, an extension in the Contract Times, to the extent permitted under Paragraphs 12.02 and 12.03, shall be the sole and exclusive remedy of the Contractor for any (1) delay in the commencement, prosecution, or completion of the Work; (2) hindrance or obstruction in the performance of the Work; (3) loss of productivity; or (4) other similar claims (collectively referred to in this paragraph as "Delays") whether or not such Delays are foreseeable. In no event shall the Contractor be entitled to any compensation or recovery of any damages, in connection with any Delay, including, without limitation, consequential damages, lost opportunity costs, impact damages, or other similar remuneration. The Owner's exercise of any of its rights or remedies under the Contract Documents (including, without limitation, ordering changes in the Work, directing suspension, rescheduling, or correction of the Work, or terminating this Agreement for its convenience), regardless of the extent or frequency of the Owner's exercise of such rights or remedies, shall not be construed as active interference with the Contractor's performance of the Work. If the Contractor submits a progress report indicating, or otherwise expressing an intention to achieve, completion of the Work prior to any completion date required by the Contract Documents or expiration of the Contract Time, no liability of the Owner to the Contractor for any failure of the Contractor to so complete the Work shall be created or implied.

G. Under a Calendar Day Contract, the Contractor may also be granted an extension of time because of unusual inclement weather that is beyond the normal weather expected for the Georgetown, Texas area. Normal weather which prevents the Contractor from performing Work is expected during a Calendar Day Contract, and is not a justification for an extension of time. The following delineates the number of days per month for which, for purposes of Calendar Day Contracts, expected normal weather will prevent performance of Work:

January.....	7 days
February.....	7 days
March.....	7 days
April.....	7 days
May.....	8 days

June.....	6 days
July.....	6 days
August.....	5 days
September.....	7 days
October.....	7 days
November.....	7 days
December.....	7 days

Days per month exceeding the number shown above may be credited as Rain Days if a Claim is made in accordance with this Article 12 and meets the following definition: a "Rain Day" is any day in which a weather event occurs at the site and is sufficient to prevent the Contractor from performing units of Work critical to maintaining the Progress Schedule.

ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 Notice of Defects

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 Access to Work

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspecting, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's Site safety procedures and programs so that they may comply therewith as applicable.

13.03 Tests and Inspections

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, it must, if requested by Engineer, be uncovered for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted in the time set forth in the Contractor's notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others), unless the Contractor fails to provide written notice as required by Paragraph 13.03.F; and Owner shall be entitled to an appropriate

decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If, the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to

Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or
2. correct such defective Work; or
3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service for the benefit of the Owner before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such

defective Work (such costs to be approved by Engineer as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. Applications for Payments

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The OWNER will pay to the CONTRACTOR the total amount of approved Application for Payment, less five percent (5%) of the amount thereof, which five percent (5%) or the highest maximum amount of retainage as may be allowed under Government Code Chapter 2253 will be retained until thirty (30) days after Final Completion of the Work, less all previous payments and less all sums that may be retained by the OWNER under the terms of this Contract. The CONTRACTOR, at the OWNER'S option, may be relieved of the obligation to complete the Work and, thereupon, the

CONTRACTOR shall receive payment of the balance due under the Contract subject to the conditions stated under paragraph 15.2.

4. Each application for payment shall be accompanied by the following, all in form and substance satisfactory to the Owner:

a. A current Contractor's lien waiver and duly executed and acknowledged sworn statement showing all Subcontractors and material suppliers with whom the Contractor has entered into Subcontracts, the amount of each such Subcontract, the amount requested for any Subcontractor and material supplier in the requested progress payment, and the amount to be paid to the Contractor from such progress payment, together with similar sworn statements from all such Subcontractors and material suppliers;

b. Duly executed waivers of mechanics' and material suppliers' liens from all Subcontractors and, when appropriate, from material suppliers and lower-tier Subcontractors establishing payment or satisfaction of payment of all amounts requested by the Contractor on behalf of such entities or persons in any previous application for payment;

c. updated Progress Schedule;

d. monthly subcontractor report;

e. Contractor's estimate of the amount of the Work performed, labor furnished, and materials included in the Work using the agreed schedule of values; and

f. any other documentation required under the Supplementary Conditions or elsewhere in the Contract Documents; and

g. All information and materials required to comply with the requirements of the Contract Documents or reasonably requested by the Owner or the Engineer.

5. The Contractor shall also comply with the following specific requirements:

a. With each application for payment, the Contractor shall submit to the Owner a written list identifying each location where materials are stored off the project site and the value of the materials at each location. The Contractor shall procure insurance satisfactory to the Owner for material stored off the project site in an amount not less than the total value thereof.

b. The consent of any surety shall be obtained to the extent required prior to payment for any materials stored off the project site.

B. Review of Applications

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations on the Site of the executed Work as an experienced and qualified design professional and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and to any other qualifications stated in the recommendation); and

c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

b. that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

a. to supervise, direct, or control the Work, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. Payment Becomes Due

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. Reduction in Payment

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

c. there are other items entitling Owner to a set-off against the amount recommended;

d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A;

e. reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Amount;

f. damage to the Owner or another contractor;

g. reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;

h. failure of the Contractor to submit a schedule of values in accordance with the Contract Documents;

i. failure of the Contractor to submit a submittal schedule in accordance with the Contract Documents;

j. failure of the Contractor to submit or update construction schedules, including Progress Schedule(s), in accordance with the Contract Documents;

k. failure of the Contractor to maintain a Record Documents;

l. failure of the Contractor to maintain weekly payroll reports;

m. failure of the Contractor to submit monthly Subcontractor reports;

n. the Contractor's neglect or unsatisfactory prosecution of the Work, including failure to clean up;

o. assessment of fines and/or penalties for violations of any federal or state law;

p. notice of potential claims by subcontractors or suppliers; or

q. failure of the Contractor to comply with any provision of the Contract Documents.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

3. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

E. No money shall be paid by the Owner upon any claim, debt, demand or account whatsoever, to any person, firm or corporation who is in arrears to the City of Georgetown for taxes; and the City of Georgetown shall be entitled to counterclaim and offset against any such debt, claim, demand or account in the amount of taxes so in arrears and no assignment or transfer of such debt, claim, demand or account after said taxes are due, shall affect the right of the Owner to so offset said taxes, and associated penalties and interest if applicable, against the same.

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

(1) The Contractor further expressly undertakes to defend the Owner and Engineer, at the Contractor's sole expense, against any actions, lawsuits, or proceedings brought against the Owner, Engineer, or any third party as a result of liens filed against the Work, the site of any of the Work, the project site and any improvements thereon, payments due the Contractor, or any portion of the property of the Owner, Engineer, or third party. The Contractor hereby agrees to indemnify and hold the Owner, Engineer, and third parties harmless against any such liens or claims of lien and agrees to pay any judgment or lien resulting from any such action, lawsuit, or proceeding.

(2) The Owner shall release any payments withheld due to a lien or claim of lien if the Contractor obtains security acceptable to the Owner or a lien bond that is (i) issued by a surety acceptable to the Owner; (ii) in a form and substance satisfactory to the Owner; and (iii) in an amount not less than two hundred percent (200%) of such lien claim. By posting a lien bond or other acceptable security, however, the Contractor shall not be relieved of any responsibilities or obligations under this paragraph, including, without limitation, the duty to defend and indemnify the Owner and Engineer. The cost of any premiums incurred in connection with such bonds and securities shall be the responsibility of the Contractor and shall not be part of, or cause any adjustment to, the Contract Price.

(3) The Contractor agrees to waive any right that it may have to assert a mechanic's or other lien against the project site and any improvements thereon, including without limitation, the Work itself. Furthermore, the Contractor will cause a similar provision, waiving all rights to a mechanic's or other lien against the property, to be included in all of its subcontracts, any sub-subcontracts, and all contracts with material suppliers.

(4) Notwithstanding the foregoing, the Owner reserves the right to settle any disputed mechanic's or material supplier's lien claim by payment to the lien claimant or by such other means as the Owner, in the Owner's sole discretion, determines is the most economical or advantageous method of settling the dispute. The Contractor shall promptly reimburse the Owner, upon demand, for any payment so made.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, , Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not

substantially complete, Engineer will within 14 days after submission of the tentative certificate to Owner notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will within said 14 days execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions.

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Engineer that such part of the Work is substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an

inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. Application for Payment

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.7;

b. consent of the surety, if any, to final payment;

c. a list of all Claims against Owner that Contractor believes are unsettled; and

d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

e. Non-Use of Asbestos Affidavit (After Construction);

f. Affidavit that all payrolls, bills for materials

and equipment, subcontracted Work, and all indebtedness connected with the Work, except as specifically noted, are paid or will be paid, or will be otherwise satisfied within the period of time required by Chapter 2251 of the Texas Government Code. Contractor's affidavit shall include documentation establishing payment or satisfaction of all such obligations such as receipts, releases, and waivers of claims and liens arising out of the Contract. The Contractor may not subsequently submit a claim on behalf of a subcontractor or vendor unless the Contractor's affidavit notes that claim as an exception; and

g. Other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or Owner's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. Engineer's Review of Application and Acceptance

1. If, on the basis of Owner's and Engineer's observation of the Work during construction and final inspection, and Owner's and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Owner and Engineer are satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less

any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and, will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such

suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's disregard of the authority of Engineer; or

4. Persistent failure to prosecute the Work in accordance with the Contract, and to insure its completion within the time, or any approved extension thereof, specified in this Contract; and/or

5. Failure to remedy defective Work condemned by the Owner; and/or

6. Failure to pay subcontractors, laborers, and material suppliers pursuant to Tex. Gov't Code Chapter 2251; and/or

7. Persistent endangerment to the safety of labor or of the Work; and/or

8. Failure to supply or maintain statutory bonds or to maintain required insurance, pursuant to the contract; and/or

9. If the CONTRACTOR is adjudged a bankrupt, or makes a general assignment for the benefit of creditors, or if a receiver is appointed for the benefit of creditors, or if a receiver is appointed on account of CONTRACTOR's insolvency, or if CONTRACTOR has otherwise demonstrated financial inability to perform the Work; and/or

10. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be

used by Contractor (without liability to Contractor for trespass or conversion),

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B, and 15.02.C.

G. In the event that Owner's termination under Paragraph 15.02 is determined to be wrongful, the termination will automatically become a termination for convenience under Paragraph 15.03, and Contractor's remedy for wrongful termination shall be limited to recovery of payments permitted for termination for convenience under Paragraph 15.03.

15.03 *Owner May Terminate For Convenience*

A. The Owner may, at any time, terminate the Contract in whole or in part for the Owner's convenience

and without cause. Termination by the Owner under this paragraph shall be by a notice of termination delivered to the Contractor specifying the extent of termination and the effective date.

B. Upon receipt of a notice of termination for convenience, the Contractor shall immediately, in accordance with instructions from the Owner, proceed with performance of the following duties regardless of delay in determining or adjusting amounts due under this paragraph:

1. cease operations as specified in the notice;

2. place no further orders and enter into no further subcontracts for materials, labor, service, or facilities except as necessary to complete continued portions of the Contract;

3. terminate all subcontracts and orders to the extent they relate to the Work terminated;

4. proceed to complete the performance of the Work not terminated; and

5. take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

C. Upon such termination, the Contractor shall recover as its sole remedy payment of the percentage of the Contract Price equal to the percentage of the Work performed satisfactorily and not previously paid for as determined by the Engineer. The Contractor hereby waives and forfeits all other claims for payment and damages, including, without limitation, anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

D. The Owner shall be credited for (1) payments previously made to the Contractor for the terminated portion of the Work; (2) claims that the Owner has against the Contractor under the Contract; and (3) the value of the materials, supplies, equipment, or other items that are to be disposed of by the Contractor that are part of the Contract Price.

ARTICLE 16 - DISPUTE RESOLUTION

16.01 *Methods and Procedures*

A. Claims shall be made by Written Notice delivered by the party making the Claim to the other party within thirty (30) calendar days after the start of the occurrence or event giving rise to the Claim and stating the general nature of the Claim. Notice of the amount of the Claim with supporting data shall be delivered within thirty (30) calendar days after Written Notice of Claim is delivered by claimant and shall represent that the adjustment claimed covers all known amounts to which

claimant is entitled.

B. Within thirty (30) calendar days of receipt of notice of the amount of the Claim with supporting data, Owner and the Contractor shall meet to discuss the Claim, after which an offer of settlement or notification of no settlement offer will be made to claimant. If claimant is not satisfied with the proposal presented, claimant shall have thirty (30) calendar days in which to:

- .1 submit additional supporting data requested by the other party;
- .2 modify the initial Claim; or
- .3 request Alternative Dispute Resolution.

16.02 *Alternative Dispute Resolution*

A. If a dispute exists concerning a Claim, the parties agree to use the following procedure prior to pursuing any other available remedies. The Owner reserves the right to include Engineer as a party.

B. Either party may give the other party written notification of any dispute not resolved in the normal course of business. Within fifteen (15) days after delivery of the notice, the receiving party shall submit to the other party a written response. The notice and response shall include (a) a statement of that party's position and a summary of arguments supporting that position, and (b) the name and title of the executive who will represent that party and of any other person will accompany that executive.

C. Within thirty (30) days after delivery of the initial notice, the executives of both parties shall meet in Georgetown, Texas at a mutually acceptable time and location, and thereafter as often as they deem reasonably necessary to attempt to resolve the dispute.

D. All reasonable requests for information made by one party to the other will be honored.

E. All negotiations are confidential and shall be treated as compromise and settlement negotiations for purpose of applicable rules of evidence.

F. Each party is required to continue to perform its obligations under the Contract Documents pending final resolution of any dispute arising out of or relating to the Contract Documents.

16.03 *Mediation*

A. If the procedure described in Paragraph 16.02 proves unsuccessful or is waived pursuant to its terms, the parties shall initiate the mediation process, as follows:

B. Any Claim arising out of or related to the Contract, shall be subject to mediation as a condition

precedent to the institution of legal or equitable proceedings by either party.

C. The parties shall endeavor to resolve their Claims by mediation. Request for mediation shall be filed in writing with the other party. The request may be made concurrently with the filing of a lawsuit but, in such event, mediation shall proceed in advance of legal or equitable proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order.

D. The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in Georgetown, Texas, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

J. Claims not resolved by mediation shall be decided by litigation. Venue shall be proper only in Williamson County, Texas.

ARTICLE 17 - MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

- 1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or
- 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

B. The following legal holidays are observed by the Owner:

<u>Holiday</u>	<u>Date Observed</u>
New Year's Day	January 1
Martin Luther King, Jr.'s Birthday	Third Monday in January

Memorial Day	Last Monday in May
Independence Day	July 4
Labor Day	First Monday in September
Thanksgiving Day	Fourth Thursday in November
Friday after Thanksgiving	Friday after Thanksgiving
Christmas Eve	December 24
Christmas Day	December 25

C. If a Legal Holiday falls on Saturday, it will be observed on the preceding Friday. If a Legal Holiday falls on Sunday, it will be observed on the following Monday. If Christmas Eve falls on a Saturday or a Sunday, the preceding Friday is observed as the Christmas Eve holiday. If Christmas Day falls on a Saturday or a Sunday, the following Monday is observed as the Christmas Day holiday.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regula-

tions, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

B. The Contractor and Owner waive all Claims against each other for consequential damages arising out of or relating to this Contract; provided, however, that in no event shall this mutual waiver be deemed to preclude an award of liquidated damages recoverable under the Agreement. This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with this Contract.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

A. This Contract is to be governed by the law of the State of Texas.

17.06 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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SECTION 00800 SUPPLEMENTARY CONDITIONS

GENERAL

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

SC-1.01 DEFINED TERMS

Add the following defined terms to Section 1.01:

- 53 *Calendar Day*: "Calendar Day" is any day of the week or month, no days being excepted.
- 54 *Working Day*: A "Working Day" is defined as any day not including Saturdays, Sundays or any legal holidays, in which weather or other conditions, not under the control of the CONTRACTOR, will permit construction of the principal units of the work for a period of not less than seven (7) hours between 7:00 a.m. and 6:00 p.m.
- 55 *Working Times*: Times of day(s) during which work may be performed. Unless authorized by the City of Georgetown, all Work shall be performed between 7:00am and 6:00pm on weekdays and, if previously authorized by as provided for in Section 6.02 herein, as applicable, between 9:00 am and 6:00 pm on Saturdays, Sundays, or Legal Holidays. When the CONTRACTOR has been authorized to perform Work during hours outside Working Times, such hours shall be considered time worked on Working days. Notwithstanding the preceding, emergency work may be done without prior permission only as provided in paragraph 6.16 herein.
- 56 *Proposal*: Proposal of Offeror, under Local Government Code section 271.113 providing for alternative project delivery methods, on prescribed forms setting forth prices for performing the Work described in the Contract Documents.
- 57 *Proposal Documents*: The advertisement or invitation for Proposals, Instruction to Offerors, the Proposal form, the Contract Documents and Addenda (NOTE: this definition only applies where proposals, rather than bids have been solicited and where allowed under the Local Government Code).

SC-4.01 AVAILABILITY OF LANDS

Add the following defined terms to Section 4.01:

- D. The Site for this project shall include the temporary and permanent easements as indicated on the Drawings.

SC-4.02 SUBSURFACE AND PHYSICAL CONDITIONS

Add the following paragraph immediately after paragraph 4.02.B:

- C. In the preparation of the Contract Documents ENGINEER relied upon the following reports of explorations and tests of subsurface conditions at the Site:
1. Memorandum dated May 2022 prepared by Terracon Consultants, Inc. entitled: “Dove Springs WWTP and San Gabriel WWTP, Georgetown Texas. The “technical data” contained in this report upon which the CONTRACTOR may rely includes the Log of Borings and laboratory test results provided in the Appendix to CIP4.
 2. Copies of the report listed in SC-4.02.C.1 that are not included with the Proposal Documents may be examined at the offices of ENGINEER during regular business hours, or may be obtained from the ENGINEER. This report is not part of the Contract Documents, but the “technical data” contained therein upon which CONTRACTOR may rely as identified and established above are incorporated therein by reference. CONTRACTOR is not entitled to rely upon other information and data utilized by ENGINEER in the preparation of Drawings and Specifications.
 3. CONTRACTOR represents that he has satisfied himself as to the subsurface conditions at the Site of the Work. The Contract Documents, including subsurface conditions, but excluding the “technical data” referenced in SC-4.02.C.2 above, are for information purposes only and are not warranted or represented in any manner to accurately show the conditions at the Site of the Work. All risks of differing site conditions shall be borne solely by the CONTRACTOR.

SC-4.03 DIFFERING SUBSURFACE OR PHYSICAL CONDITIONS

In Section 4.03.A.2, delete the last sentence in its entirety and add the following language: “All risks of differing site conditions shall be borne solely by the Contractor, except for mitigation of karst features which will be paid as a change order.”

SC-5.02 LICENSED SURETIES AND INSURERS

Add the following to Section 5.02 A:

Surety and insurance companies from which the bonds and insurance for this Project are purchased shall have a Best’s rating of no less than A:VII, in addition to other requirements specified herein.

SC-5.04 CONTRACTOR’S LIABILITY INSURANCE

Add the following to Section 5.04.B.1:

Include the following parties or entities as additional insured:

CDM Smith Inc.
9430 Research Blvd., Suite 1-200
Austin, Texas 78759

SC-5.04 Contractor's Liability Insurance
Replace Paragraph 5.04 with the following SC-5.04

5.04 *Other Requirements: Bond and Insurance.*

A. General Requirements:

1. CONTRACTOR shall purchase and maintain insurance in the types and amounts indicated below for the duration of the Contract (unless a longer duration is specified), which shall include items owned by OWNER in the care, custody and control of CONTRACTOR prior to and during the term of the Contract and all warranty periods. Failure to purchase and maintain the required insurance shall be grounds for Termination of the Contract or Suspension of the Work by OWNER. Except for the Worker's Compensation policy, the other insurance policies required by the Contract to be obtained by CONTRACTOR must state that OWNER, its officials, directors, employees, representatives, and volunteers are added as additional insureds with regard to operations and activities by or on behalf of the named insureds performed under contract with OWNER. The additional insured status must cover completed operations as well, and the policy covering completed work must remain in effect until the expiration of the statute of repose.
2. CONTRACTOR must complete and forward the required Certificates of Insurance to OWNER before the Contract is executed as verification of coverage required below. CONTRACTOR shall not commence Work until the required insurance is obtained and until such insurance has been reviewed by OWNER. Approval of insurance by OWNER shall not relieve or decrease the liability of CONTRACTOR hereunder and shall not be construed to be a limitation of liability on the part of CONTRACTOR. CONTRACTOR must also complete and forward the required Certificates of Insurance to OWNER whenever a previously identified policy period has expired as verification of continuing coverage.
3. Contractor's insurance coverage is to be written by companies licensed to do business in the State of Texas at the time the policies are issued and shall be written by companies with A.M. Best ratings of B+VII or better, except for hazardous material insurance which shall be written by companies with A.M. Best ratings of A- or better.
4. All endorsements naming the OWNER as additional insured, waivers, and notices of cancellation endorsements as well as the Certificate of Insurance shall indicate: City of Georgetown, 113 E. 8th Street, Georgetown, Texas 78626, ATTN: Contract Manager.
5. The "other" insurance clause shall not apply to the OWNER where the OWNER is an additional insured shown on any policy. It is agreed that the CONTRACTOR's insurance shall be considered primary with respect to any insurance or self insurance carried by OWNER. The CONTRACTOR'S

insurance shall apply separately to each insured against whom a claim is made and/or lawsuits brought, except with respect to the limits of insurer's liability.

6. If insurance policies are not written for amounts specified below, CONTRACTOR shall carry Umbrella or Excess Liability Insurance for any differences in amounts specified. If Excess Liability Insurance is provided, it shall follow the form of the primary coverage.
7. OWNER shall be entitled, upon request and without expense, to receive certified copies of policies and endorsements thereto and may make any reasonable requests for deletion or revision or modification of particular policy terms, conditions, limitations, or exclusions except where policy provisions are established by law or regulations binding upon either of the parties hereto or the underwriter on any such policies.
8. OWNER reserves the right to review the insurance requirements set forth during the effective period of this Contract and to make reasonable adjustments to insurance coverage, limits, and exclusions when deemed necessary and prudent by OWNER based upon changes in statutory law, court decisions, the claims history of the industry or financial condition of the insurance company as well as CONTRACTOR.
9. CONTRACTOR shall not cause any insurance to be canceled nor permit any insurance to lapse during the term of the Contract or as required in the Contract.
10. CONTRACTOR shall be responsible for premiums, deductibles and self-insured retentions, if any, stated in policies. All deductibles or self-insured retentions shall be disclosed on the Certificate of Insurance.
11. The policies must contain the following language: "This policy shall not be cancelled, materially changed, or not renewed until after thirty (30) days prior written notice has been given to OWNER." In addition, CONTRACTOR shall provide OWNER thirty (30) days written notice of erosion of the aggregate limits below occurrence limits for all applicable coverages indicated within the Contract.
12. If OWNER-owned property is being transported or stored off-Site by CONTRACTOR, then the appropriate property policy will be endorsed for transit and storage in an amount sufficient to protect OWNER's property.
13. The insurance coverages required under this contract are required minimums and are not intended to limit the responsibility or liability of CONTRACTOR.
14. Without limiting any of the other obligations or liabilities of the CONTRACTOR, the CONTRACTOR shall require each Subcontractor performing work under the Contract, at the Subcontractor's own expense, to maintain during the term of the Contract, the same stipulated minimum insurance including the required provisions and additional policy conditions as shown above. As an alternative, the CONTRACTOR may include its Subcontractors as additional insureds on its own coverage as prescribed under these requirements. The CONTRACTOR's certificate of insurance shall note in such event that the Subcontractors are included as additional insureds and that CONTRACTOR agrees to provide Workers' Compensation for the Subcontractors and their

employees. The CONTRACTOR shall obtain and monitor the certificates of insurance from each Subcontractor in order to assure compliance with the insurance requirements. The CONTRACTOR must retain the certificates of insurance for the duration of the Contract plus 5 years and shall have the responsibility of enforcing these insurance requirements among its subcontractors. The OWNER shall be entitled, upon request and without expense, to receive copies of these certificates.

- B. Business Automobile Liability Insurance. Provide coverage for all owned, non-owned and hired vehicles in an amount not less than \$1,000,000 combined single limit per accident for bodily injury and property damage. The policy shall contain the following endorsements in favor of OWNER:

Waiver of Subrogation endorsement TE 2046A;

30 day Notice of Cancellation endorsement TE 0202A; and

Additional Insured endorsement TE 9901 B.

Provide coverage in the following types and amounts:

A minimum combined bodily injury and property damage limit of \$1,000,000 per occurrence. No aggregate shall be permitted for this type of coverage.

Such insurance shall include coverage for loading and unloading hazards.

- C. Workers' Compensation and Employers' Liability Insurance. Coverage shall be consistent with statutory benefits outlined in the Texas Workers' Compensation Act (Section 401). CONTRACTOR shall assure compliance with this Statute by submitting two (2) copies of a standard certificate of coverage (e.g. ACCORD form) to Owner's Representative for every person providing services on the Project as acceptable proof of coverage. The required Certificate of Insurance must be presented as evidence of coverage for CONTRACTOR. Workers' Compensation Insurance coverage written by the Texas Workers Compensation Fund is acceptable to OWNER. CONTRACTOR's policy shall apply to the State of Texas and include these endorsements in favor of OWNER:

Waiver of Subrogation, form WC 420304; and

30 day Notice of Cancellation, form WC 420601.

The minimum policy limits for Employers' Liability Insurance coverage shall be the minimum amounts required to meet the statutory requirements of Texas Labor Code, Section 401.011(44), or the following, whichever is greater:

\$1,000,000 bodily injury per accident, and

\$1,000,000 bodily injury by disease policy limit; and

\$1,000,000 bodily injury by disease each employee; and

\$1,000,000 Employer's Liability.

D. Commercial General Liability Insurance. The Policy shall contain the following provisions:

Blanket contractual liability coverage for liability and indemnifications assumed under the Contract and all contracts relative to this Project.

Completed Operations/Products Liability until the end the statute of repose period.

Explosion, Collapse and Underground (X, C & U) coverage.

Independent Contractor's coverage.

Aggregate limits of insurance per project, endorsement CG 2503.

OWNER listed as an additional insured, endorsement CG 2010.

30 day notice of cancellation in favor of OWNER, endorsement CG 0205.

Waiver of Transfer of Recovery Against Others in favor of OWNER, endorsement CG 2404.

Fully insuring CONTRACTOR'S or Subcontractor's liability for bodily injury and property damages with a combined bodily injury (including death) and property damage minimum limit of:

\$1,000,000 per occurrence

\$2,000,000 general aggregate

\$2,000,000 products and completed operations aggregate

Coverage shall be on an "occurrence" basis.

E. Property Floater. Contractor shall obtain and maintain Property Floater in an amount sufficient to cover the replacement value of materials on site.

F. Umbrella Liability Insurance. The CONTRACTOR shall obtain, pay for, and maintain umbrella liability insurance during the contract term, insuring the CONTRACTOR (or subcontractor) for an amount not less than \$2,000,000 that provides coverage at least as broad and applies in excess of and follows the form of the primary liability coverages required in Article 5. The policy shall provide "drop down" coverage where underlying primary insurance coverages limits are insufficient or exhausted.

G. Asbestos Abatement Liability Insurance. If the Work or the Project involves asbestos containing materials, the CONTRACTOR shall obtain Asbestos Abatement Liability Insurance for liability arising from the encapsulation, removal, handling, storage, transportation, and disposal of asbestos containing materials. The combined single limit for bodily injury and property damage shall be a minimum of \$1,000,000 per occurrence. If claims made, the claims-made,

the claims made form shall provide that the period of coverage shall be: Continuous coverage for the term of the Contract plus the warranty period of at least one (1) year, and an extended discovery period for a minimum of five (5) years, which shall begin at the end of the warranty period.

H. Completed Work Insurance.

SC-5.045 Bonds.

A. *General.*

1. Bonds, when required by the Contract or by Chapter 2253 of the Texas Government Code, shall be executed on forms furnished by or acceptable to OWNER. All bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.
2. If the surety on any bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business is terminated in the State of Texas or it ceases to meet the requirements of the preceding paragraph, CONTRACTOR shall within ten (10) days thereafter substitute another bond and surety, both of which must be acceptable to OWNER.
3. When Performance Bonds and/or Payment Bonds are required, each shall be issued in an amount of one hundred percent (100%) of the Contract Amount as security for the faithful performance and/or payment of all CONTRACTOR's obligations under the Contract Documents. Performance Bonds and Payment Bonds shall be issued by a solvent surety company authorized to do business in the State of Texas, and shall meet any other requirements established by law or by OWNER pursuant to applicable law. Any surety duly authorized to do business in Texas may write Performance and Payment Bonds on a project without reinsurance to the limit of 10 percent of its capital and surplus. Such a surety must reinsure any obligations over 10 percent.

B. *Performance Bond.*

1. If the Contract Amount exceeds \$100,000, CONTRACTOR shall furnish OWNER with a Performance Bond in the form set out by OWNER. The Performance Bond shall be effective for the Contract Time and through all warranty period(s).
2. If the Contract Amount exceeds \$50,000 but is less than or equal to \$100,000, CONTRACTOR shall furnish OWNER with a Performance Bond in the form set out by OWNER, unless the original Contract Time is 60 Calendar Days or less, in which case CONTRACTOR can agree to the following terms and conditions for payment in lieu of providing a Performance Bond: no money will be paid to CONTRACTOR until completion and acceptance of the Work by OWNER; CONTRACTOR shall be entitled to receive 95% of the Contract Amount following Final Completion, and the remaining 5% of the Contract Amount following the one year warranty period.
3. If the Contract Amount is less than or equal to \$50,000, CONTRACTOR will not be required to furnish a Performance Bond.

4. If a Performance Bond is required to be furnished, it shall extend for the one year warranty period, or longer if the warranty periods are longer.
- C. *Payment Bond.*
 1. If the Contract Amount exceeds \$50,000, CONTRACTOR shall furnish OWNER with a Payment Bond in the form set out by OWNER.
 2. If the Contract Amount is less than or equal to \$50,000, CONTRACTOR will not be required to furnish a Payment Bond; provided that no money will be paid to CONTRACTOR until completion and acceptance of the Work by OWNER.
- D. *Power of Attorney.* Each bond shall be accompanied by a valid Power of Attorney (issued by the surety company and attached, signed and sealed with the corporate embossed seal, to the bond) authorizing the attorney in fact who signs the bond to commit the company to the terms of the bond, and stating any limit in the amount for which the attorney can issue a single bond.
- E. *Bond Indemnification.* The process of requiring and accepting bonds and making claims thereunder shall be conducted in compliance with Tex. Gov't Code, Chapter 2253. IF FOR ANY REASON A STATUTORY PAYMENT OR PERFORMANCE BOND IS NOT HONORED BY THE SURETY, THE CONTRACTOR SHALL FULLY INDEMNIFY AND HOLD THE OWNER HARMLESS OF AND FROM ANY COSTS, LOSSES, OBLIGATIONS OR LIABILITIES IT INCURS AS A RESULT.
- F. *Furnishing Bond Information.* OWNER shall furnish certified copies of the payment bond and the related Contract to any qualified person seeking copies who complies with Tex. Gov't Code, §2253.026.
- G. *Claims on Payment Bonds.* Claims on payment bonds must be sent directly to the CONTRACTOR and his surety in accordance with Tex. Gov't Code § 2253.041. All Payment Bond claimants are cautioned that no lien exists on the funds unpaid to the CONTRACTOR on such Contract, and that reliance on notices sent to the OWNER may result in loss of their rights against the CONTRACTOR and/or his surety. The OWNER is not responsible in any manner to a claimant for collection of unpaid bills, and accepts no such responsibility because of any representation by any agent or employee.
- H. *Payment Claims when Payment Bond is not required.* The rights of Subcontractors regarding payment are governed by Tex. Prop. Code, §§53.231 – 53.239 when the value of the Contract between the OWNER and the CONTRACTOR is less than \$25,000.00. These provisions set out the requirements for filing a valid lien on funds unpaid to the CONTRACTOR as of the time of filing the claim, actions necessary to release the lien and satisfaction of such claim.
- I. *Minimum Standards for Sureties.* Sureties shall be listed on the US Department of the Treasury's Listing Approved Sureties stating companies holding Certificates of Authority as acceptable sureties on Federal Bonds and acceptable reinsuring companies (Department Circular 570).

SC-6.02 LABOR; WORKING HOURS

Add the following defined terms to Paragraph 6.02:

- C. Regular Working Hours shall be between 7 am and until 30 minutes prior to sunset or 6 pm whichever is earlier, and, if previously authorized in writing by the City of Georgetown, between 9:00 am and 6:00 pm on Saturdays, Sundays, or Legal Holidays.
- D. The Contractor shall work Regular Working Hours on normal Working Days as defined in Section 1.01.

Add the following provision on prevailing wages to Paragraph 6.02:

E. PREVAILING WAGE RATES: This Contract is subject to Government Code Chapter 2258 concerning payment of Prevailing Wage Rates. The OWNER will determine the general prevailing rates in accordance with Government Code Chapter 2258. The applicable provisions include, but are not limited to the following:

§ 2258.021. Right to be Paid Prevailing Wage Rates

(a) A worker employed on a public work by or on behalf of the state or a political subdivision of the state shall be paid:

(1) not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which the work is performed; and

(2) not less than the general prevailing rate of per diem wages for legal holiday and overtime work.

(b) Subsection (a) does not apply to maintenance work.

(c) A worker is employed on a public work for the purposes of this section if the worker is employed by a contractor or subcontractor in the execution of a contract for the public work with the state, a political subdivision of the state, or any officer or public body of the state or a political subdivision of the state.

§ 2258.023. Prevailing Wage Rates to be Paid by Contractor and Subcontractor; Penalty

(a) The contractor who is awarded a contract by a public body or a subcontractor of the contractor shall pay not less than the rates determined under Section 2258.022 to a worker employed by it in the execution of the contract.

(b) A contractor or subcontractor who violates this section shall pay to the state or a political subdivision of the state on whose behalf the contract is made, \$60 for each worker employed for each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the contract. A public body awarding a contract shall specify this penalty in the contract.

(c) A contractor or subcontractor does not violate this section if a public body awarding a contract does not determine the prevailing wage rates and specify the rates in the contract as provided by Section 2258.022.

(d) The public body shall use any money collected under this section to offset the costs incurred in the administration of this chapter.

(e) A municipality is entitled to collect a penalty under this section only if the municipality has a population of more than 10,000.

§ 2258.024. Records

(a) A contractor and subcontractor shall keep a record showing:

(1) the name and occupation of each worker employed by the contractor or subcontractor in the construction of the public 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 public body.

§ 2258.025. Payment Greater Than Prevailing Rate Not Prohibited

This chapter does not prohibit the payment to a worker employed on a public work an amount greater than the general prevailing rate of per diem wages.

SC-6.13.B Trench and Shoring Safety

Add the following Paragraph 6.13.B.1.

As required by the Texas Health & Safety Code, Title 9, Subtitle A, Chapter 756, Subchapter C, Contractor is required to comply with the trench safety standards of the Occupational Safety and Health Administration, 29 C.F.R. 1926, Subpart P, Excavations, in effect during the period of construction of the Project. Contractor agrees to comply with, and Owner agrees to include in the Bid Documents, a copy of any special shoring requirements, if any, required for the Project. Owner agrees to furnish to Contractor a copy of any geotechnical information that was obtained by the Owner for use by the Contractor in the design of the trench safety system, if any.

SC-14.02 Article 14 - Payments To Contractor And Completion

Change the 1st sentence in Paragraph 14.02.C.1 from “Ten days after presentation of the Application for Payment to OWNER...” to “Thirty (30) days after presentation of the Application for Payment to OWNER...”

SC-14.02.D Article 14 – Progress Payments

Add the following language after Article 14.02.D:

E. Progress Payment for Insurance, Bonds, Mobilization and Demobilization

1. Payment for Insurance and Bonds

- a. Contractor's Insurance and Bonds shall include costs for insurance plus Performance and Payment Bonds.
- b. Payment for Insurance and Bonds will be made on the first approved monthly pay request with suitable evidence of the cost thereof. The amount should agree with the suitable evidence provided and the Schedule of Values.
- c. The amount of the Insurance and Bonds on the Schedule of Values shall not exceed 2.5 percent of the total contract amount. The amount of the Insurance, Bonds, and Mobilization/Demobilization shall not exceed 5 percent of the total contract amount.

2. Payment for Mobilization and Demobilization

- a. Mobilization and Demobilization includes costs of personnel, equipment and supplies, construction offices and the utility costs associated therewith, etc.
- b. Payments for Mobilization and Demobilization will be made as follows based upon the "adjusted contract amount" for construction items. The "adjusted contract amount" is defined as the total contract amount less the amount for Insurance and Bonds (Article 14.02.E.1 above) and less the amount for Mobilization and Demobilization.
- c. When 1 percent of the adjusted contract amount for construction items is earned, 25 percent of the mobilization and demobilization amount shown in the Schedule of Values will be paid.
- d. When 10 percent of the adjusted contract amount for construction items is earned, 50 percent of the mobilization and demobilization amount shown in the Schedule of Values will be paid.
- e. When 25 percent of the adjusted contract amount for construction items is earned, 75 percent of the mobilization and demobilization amount shown in the Schedule of Values will be paid.
- f. Upon Final Completion of all Work items, payment for the remainder of the mobilization and demobilization amount shown in the Schedule of Values will be made.
- g. The amount for Insurance, Bonds, and Mobilization/Demobilization shall not exceed 5 percent of the total contract amount.

SC-17.02 Delete the second sentence of Paragraph 17.02.

SC-17.07 Independent Contractor

Add the following Paragraph 17.07:

The Contract shall not be construed as creating an employer/employee relationship, a partnership, or a joint venture. The Contractor's services shall be those of an independent contractor. The Contractor agrees and understands that the Contract does not grant any rights or privileges established for employees of the Owner.

SC-17.08 Prohibition of Gratuities

Add the following Paragraph 17.08:

The Owner may, by Written Notice to the Contractor, terminate the Contract without liability if it is determined by the Owner that gratuities were offered or given by the Contractor or any agent or representative of the Contractor to any officer or employee of the Owner with a view toward securing the Contract or securing favorable treatment with respect to the awarding or amending or the making of any determinations with respect to the performing of such Contract. In the event the Contract is terminated by the Owner pursuant to this provision, the Owner shall be entitled, in addition to any other rights and remedies, to recover or withhold the amount of the cost incurred by the Contractor in providing such gratuities.

SC-17.09 Prohibition Against Personal Interest in Contracts

Add the following Paragraph 17.09

No officer, employee, independent consultant, or elected official of the Owner who is involved in the development, evaluation, or decision-making process of the performance of any solicitation shall have a financial interest, direct or indirect, in the Contract resulting from that solicitation. Any violation of this provision, with the knowledge, expressed or implied, of the Contractor shall render the Contract voidable by the Owner.

SC-18. Article 18 – Right to Audit

Add the following Article 18.

18.01 Whenever the Owner enters into any type of contractual arrangement with the Contractor, then the Contractor's "records" shall upon reasonable notice be open to inspection and subject to audit and/or reproduction during normal business working hours. The Owner's representative, or an outside representative engaged by the Owner, may perform such audits. The Contractor shall maintain all records relating to this Contract for four (4) years from the date of final payment under this Contract, or until pending litigation has been completely and fully resolved, whichever occurs later.

18.02 The Owner shall have the exclusive right to examine the records of the Contractor. The term "records" as referred to herein shall include any and all information, materials and data of every kind and character, including without limitation records, books, papers, documents, contracts, schedules, commitments, arrangements, notes, daily diaries, reports, drawings, receipts, vouchers and memoranda, and any and all other agreements, sources of information and matters that may, in the Owner's judgment, have any bearing on or pertain to any matters, rights, duties or obligations under or covered by any contract document. Such records shall include (hard copy, as well as electronic data), written policies and procedures, time sheets, payroll registers, cancelled checks, personnel file data, correspondence, e-mail,

general ledger entries, and any other record in the Contractor's possession which may have a bearing on matters of interest to the Owner in connection with the Contractor's dealings with the Owner (all of the foregoing are hereinafter referred to as "records"). In addition, the Contractor shall permit interviews of employees as well as agents, representatives, vendors, Subcontractors and other third parties paid by the Contractor to the extent necessary to adequately permit evaluation and verification of the following:

- A. The Contractor's compliance with Contract Documents;
- B. The Contractor's compliance with the Owner's business ethics policies; and
- C. If necessary, the extent of the Work performed by the Contractor at the time of Contract termination.

18.03 The Contractor shall require all payees (examples of payees include Subcontractors, insurance agents, material suppliers, etc.) to comply with the provisions of this Article 17 by securing the requirements hereof in a written agreement between the Contractor and payee. Such requirements include a flow-down right of audit provision in contracts with payees that also apply to Subcontractors and Sub-subcontractors, material suppliers, etc. The Contractor shall cooperate fully and shall require Payees and all of the Contractor's Subcontractors to cooperate fully in furnishing or in making available to the Owner from time to time whenever requested, in an expeditious manner, any and all such information, materials, and data.

18.04 The Owner's authorized representative or designee shall have reasonable access to the Contractor's facilities, shall be allowed to interview all current or former employees to discuss matters pertinent to the performance of this Contract, and shall be provided adequate and appropriate work space in order to conduct audits in compliance with this Article 17.

18.05 If an audit inspection or examination in accordance with this Article 17 discloses overpricing or overcharges of any nature by the Contractor to the Owner in excess of one-half of one percent (0.5%) of the total contract billings, then the reasonable actual cost of the Owner's audit shall be reimbursed to the Owner by the Contractor. Any adjustments and/or payments, which must be made as a result of any such audit or inspection of the Contractor's invoices and/or records, shall be made within a reasonable amount of time (not to exceed 90 days) from presentation of the Owner's findings to the Contractor.

18.06 The Contractor shall take reasonable actions to prevent any actions or conditions which could result in a conflict with the Owner's best interests. These obligations shall apply to the activities of the Contractor's employees, agents, Subcontractors, etc. in their dealings and relations with the Owner's current and former employees and their relatives. For example, the Contractor's employees, agents or Subcontractors should not make or provide to be made any employment, gifts, extravagant entertainment, payments, loans or other considerations to the Owner's representatives, employees or their relatives.

18.07 It is also understood and agreed by the Contractor that any solicitation of gifts or any other item of value by anyone representing the Owner is to be reported within two (2) business working days to the Owner at the following telephone number: 512-930-3723. Failure to report any such solicitations or offers shall be deemed a material breach of contract entitling the Owner to pursue damages resulting from the failure to comply with this provision.

END OF SECTION

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SECTION 00800 HH
CITY OF GEORGETOWN
ADOPTED PREVAILING WAGE RATES

CITY OF GEORGETOWN ADOPTED PREVAILING WAGE RATES

Position	Recommended hourly rate
Acoustic Ceiling Installer	Davis Bacon
Air Tool Operator	Davis Bacon
Asphalt Distributor Operator	Davis Bacon
Asphalt Paving Machine Operator	Davis Bacon
Asphalt Raker	Davis Bacon
Asphalt Shoveler	Davis Bacon
Boilermaker	Davis Bacon
Bricklayer/Stone Mason, Entry Level	9.00
Bricklayer/Stone Mason, Journeyman	14.00
Broom or Sweeper Operator	Davis Bacon
Bulldozer Operator, Over 150 HP	Davis Bacon
Bulldozer Operator, Under 150 HP	Davis Bacon
Carpenter Finisher, Journeyman	15.97
Carpenter, Entry Level	10.00
Carpenter, Intermediate Level	11.88
Caulker	Davis Bacon
Cement Finisher, Entry Level	Davis Bacon
Cement finisher, Journeyman	Davis Bacon
Cement Mason, Intermediate Level	Davis Bacon
Concrete Finisher-Paving	Davis Bacon
Concrete Finisher-Structures	Davis Bacon
Concrete Paving Curbing Machine Operator	Davis Bacon
Concrete Paving Finishing Machine Operator	Davis Bacon

Concrete Rubber	Davis Bacon
Construction and Building Inspectors	Davis Bacon
Crane, Clamshell, Backhoe, Derrick, Dragline, Shovel Operator	Davis Bacon
Drywall System Installer, Entry Level	10.00
Drywall System Installer, Journeyman	13.00
Earth Drillers, Except Oil and Gas	DB
Electrician, Apprentice	13.00
Electrician, Entry Level	9.00
Electrician, Journeyman (Certificate)	19.00
Electrician, Master/Certified	22.67
Elevator/Escalator Installer	Davis Bacon
Elevator/Escalator Mechanic	Davis Bacon
Equipment Operator, Crane	19.00
Equipment Operator, Heavy	11.75
Equipment Operator, Light	10.00
Explosive Workers, Ordnance Handling Experts and Blasters	Davis Bacon
Fireproofing Installer	Davis Bacon
First-line Supervisors/Managers of Construction Trades and Extraction Workers	Davis Bacon
Flagger	Davis Bacon
Floor Layer, Helper	Davis Bacon
Floor Layer, Resilient Floor Installer	Davis Bacon
Form Builder/Setter, Structures	Davis Bacon
Form Setter, Paving and Curb	Davis Bacon
Foundation Drill Operator, Crawler Mounted	Davis Bacon
Foundation Drill Operator, Truck Mounted	Davis Bacon

Front End Loader Operator	Davis Bacon
Gardener	Davis Bacon
Glazier	Davis Bacon
Ground Man	Davis Bacon
Hazardous Materials Removal Workers	Davis Bacon
Highway Maintenance Workers	Davis Bacon
HVAC Mechanic, Journeyman	16.25
HVAC Sheet Metal Worker, Intermediate Level	11.75
HVAC, Entry Level	9.00
Insulation Workers, Floor, Ceiling, Walls	Davis Bacon
Insulation Workers, Mechanical	Davis Bacon
Iron Worker, Entry Level	10.00
Iron Worker, Reinforcing, Intermediate Level	14.50
Iron Worker, Structural Journeyman	14.50
Irrigation Technician	Davis Bacon
Laborer, Common	8.50
Laborer, Utility	9.67
Landscape Foreman	Davis Bacon
Lather	Davis Bacon
Lineman	Davis Bacon
Mechanic	Davis Bacon
Mechanic Lead, Journeyman	15.67
Millwright	Davis Bacon
Mixer Operator	Davis Bacon
Mixer Operator, Concrete Paving	Davis Bacon

Motor Grader Operator, Fine Grade	Davis Bacon
Motor Grader Operator, Rough	Davis Bacon
Oiler	Davis Bacon
Painter, Sprayer	10.63
Painter, Structures	10.63
Painter, Wallcover	10.63
Pavement Marking Machine Operator	Davis Bacon
Pipefitter	Davis Bacon
Pipelayer	Davis Bacon
Piping/Duct Insulator	Davis Bacon
Planer Operator	Davis Bacon
Plumber (excluding HVAC), Intermediate Level	12.00
Plumber Lead, Journeyman	20.00
Powder Man	Davis Bacon
Reinforcing Steel Setter, Entry Level	10.00
Reinforcing Steel Setter, Journeyman	11.67
Reinforcing Steel Setter, Paving	Davis Bacon
Roller Operator, Pneumatic, Self-Propelled	Davis Bacon
Roller Operator, Steel Wheel, Plant Mix Pavement	Davis Bacon
Rofer, Metal	11.00
Roofing Foreman	Davis Bacon
Sandblaster	Davis Bacon
Scraper Operator	Davis Bacon
Servicer	Davis Bacon
Sheet Metal Mechanic, Journeyman	17.50

Sign Installer (PGM)	Davis Bacon
Slip Form Machine Operator	Davis Bacon
Spreader Box Operator	Davis Bacon
Structural Steel Worker	Davis Bacon
Tapers	Davis Bacon
Terrazzo Workers and Finishers	Davis Bacon
Tile and Marble Worker, Journeyman	Davis Bacon
Tile Setter, Intermediate Level	Davis Bacon
Tractor Operator, Crawler Type	Davis Bacon
Traveling Mixer Operator	Davis Bacon
Trenching Machine Operator, Heavy	Davis Bacon
Truck Driver Tandem Axle Semi-Trailer	13.00
Truck Driver, Lowboy-Float	Davis Bacon
Truck Driver, Single Axle, heavy	Davis Bacon
Truck Driver, Single Axle, Light	13.44
Wagon Drill, Boring Machine, Post hole Driller Operator	Davis Bacon
Waterproofer	Davis Bacon
Welder Apprentice	10.00
Welder Journeyman	18.00
Work Zone Barricade Servicer	Davis Bacon

"General Decision Number: TX20230023 01/06/2023

Superseded General Decision Number: TX20220023

State: Texas

Construction Types: Heavy (Sewer/Water Treating Plant and Sewer/Incid. to Hwy.)

Counties: Bell, Bosque, Coryell, Falls, Freestone, Hamilton, Hill, Lampasas, Leon, Limestone, McLennan, Milam, Mills, Navarro, Robertson and Williamson Counties in Texas.

WATER & SEWAGE TREATMENT PLANTS AND LIFT PUMP STATIONS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$16.20 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 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number Publication Date
0 01/06/2023

SUTX1990-003 02/09/1990

	Rates	Fringes
CARPENTER.....	\$ 9.00 **	
CEMENT MASON/CONCRETE FINISHER...	\$ 8.00 **	
ELECTRICIAN.....	\$ 13.45 **	.80+8 1/2%
Form Builder.....	\$ 7.25 **	
Form Setter.....	\$ 7.25 **	
LABORER.....	\$ 7.25 **	
Pipelayer.....	\$ 7.50 **	
Power equipment operators:		
Bulldozers.....	\$ 7.25 **	
Cranes, Clamshells, Backhoes, Derricks, Dragline, Shovels.....	\$ 7.25 **	
Front End Loaders.....	\$ 10.00 **	
Scrapers.....	\$ 7.25 **	
Steel Setter.....	\$ 9.50 **	
Steel Worker.....	\$ 7.25 **	
Truck drivers:		
Tandem Axles.....	\$ 7.25 **	
Transit Mix.....	\$ 7.25 **	
Utility Laborer.....	\$ 7.25 **	

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

=====
** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$16.20) or 13658 (\$12.15). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors 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, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is

like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a

new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

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Change Order

No. _____

Date of Issuance: _____ Effective Date: _____

Project: San Gabriel WWTP Rehabilitation Improvements	Owner: City of Georgetown	Owner's Contract No.: 23-0041-CIP
Project No.: PRJ000165	Date of Contract:	
Contractor:	Engineer's Project No.: 264953	

The Contract Documents are modified as follows upon execution of this Change Order:

Description:

Attachments (list documents supporting change):

CHANGE IN CONTRACT PRICE:	CHANGE IN CONTRACT TIMES:
Original Contract Price: \$ _____	Original Contract Times: <input type="checkbox"/> Working days <input type="checkbox"/> Calendar days Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: \$ _____	[Increase] [Decrease] from previously approved Change Orders No. _____ to No. _____: Substantial completion (days): _____ Ready for final payment (days): _____
Contract Price prior to this Change Order: \$ _____	Contract Times prior to this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
[Increase] [Decrease] of this Change Order: \$ _____	[Increase] [Decrease] of this Change Order: Substantial completion (days or date): _____ Ready for final payment (days or date): _____
Contract Price incorporating this Change Order: \$ _____	Contract Times with all approved Change Orders: Substantial completion (days or date): _____ Ready for final payment (days or date): _____

RECOMMENDED: By: _____ Engineer (Authorized Signature) Date: _____ Approved by Funding Agency (if applicable): _____	ACCEPTED: By: _____ Owner (Authorized Signature) Date: _____	ACCEPTED: By: _____ Contractor (Authorized Signature) Date: _____
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Change Order

Instructions

A. GENERAL INFORMATION

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Price or Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

B. COMPLETING THE CHANGE ORDER FORM

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

TECHNICAL SPECIFICATIONS

SECTION CIP1 – DEFINITION OF TERMS

CIP1.01

DEFINITIONS

- A. Wherever in these specifications or in other contract documents, the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:
1. CITY - The City of Georgetown, party of the First Part.
 2. COUNCIL - The Georgetown City Council.
 3. COUNTY - A political Subdivision of the State.
 4. ENGINEER - Representative of the City.
*ENGINEER - Representative of the Contractor or the Developer.
 5. INSPECTOR - The authorized representative of the City assigned to inspect any or all parts of the work and the materials to be used therein.
 6. CONTRACTOR - The individual, firm or corporation or any combination thereof, Party of the Second Part, with which the contract is made by the City, Developer or Public Cooperation.
 7. SUPERINTENDENT - The representative of the Contractor authorized to receive and fulfill instructions from the Engineer or representative of the City, and who shall supervise and direct the construction.
 8. PAVEMENT DESIGN MANUAL - Texas Department of Transportation manual outlining procedure to be followed in the design and control of asphaltic concrete and portland cement concrete mixes for structures and pavements.
 9. MANUAL OF TESTING PROCEDURES - Texas Department of Transportation Materials and Tests Division manual outlining testing methods and procedures.
 10. PLANS - The drawings approved by the City, or true reproductions thereof, which show the location, character, dimensions, and details of the work and which are a part of the contract. Plans and specifications to be prepared by a Professional Engineer registered in the State of Texas.
 11. SPECIFICATIONS - The directions, provisions and requirements contained herein or in the Special Provisions, supplemented by such “Special Provisions or Standards” as may be issued or made pertaining to the method and manner or performing the work or qualities of materials to be furnished. Where the phrases “or directed by the City”, “ordered by the City”, or “to the satisfaction of the City” occur, it is to be understood that the directions, orders, or instructions of which they relate are within the limitations of, and authorized by the contract. “Special Provisions” will cover work pertaining to a particular project included in the proposal but not covered by the specifications. Where reference is made to specifications of ASTM, AWWA, AASHTO or Bulletins and Manuals of the Texas Department of Transportation it shall be construed to mean the latest standard or tentative standard in effect on the date of the proposal.

12. RIGHT OF WAY - The land provided for a highway or street, owned by the City of Georgetown or the municipality in which the highway or street is in.
13. ROADWAY - The portion of the highway or street within the limits of construction.
14. ROADBED - The graded portion of the roadway between the intersection of top and side slopes upon which the base course, surface course, shoulders and median are constructed.
15. SUBGRADE - That portion of the roadbed upon which the subbase, base, or pavement structure is to be placed.
16. BRIDGES - Structures of over 20-foot span measured from face to face of abutments, or in case of copings, from face to face of copings, and multiple span structures of over 20-foot length, measured between inside of end walls along the centerline of the roadbed.
17. CULVERTS - All drainage structures not defined as bridges.
18. TEMPORARY STRUCTURES - All temporary bridges and structures required to maintain traffic during the construction of the work.
19. SUBSTRUCTURE - That part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls and wing walls of abutments shall be considered as parts of the substructure.
20. SUPERSTRUCTURE - The part of the structure above the bridge seats or above the springing lines of arches.
21. THE WORK - The work shall include the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.
22. PROJECT - The specific section or sections of the highway or street together with all appurtenances and construction to be performed thereon under the contract.
23. ASTM - American Society for Testing Materials.
24. AASHTO - American Association of State Highway and Transportation Officials.
25. ANSI - American National Standards Institute.
26. API - American Petroleum Institute.
27. UL - Underwriters Laboratory, Inc.
28. SCREENS AND SIEVES - As defined by the ASTM.
29. HIGHWAY, STREET OR ROAD - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas-highway or road.
30. ARTERIAL HIGHWAY OR STREET - A general term denoting a highway or street primarily for through traffic, usually on a continuous route.

31. MAJOR STREET OR MAJOR HIGHWAY - An arterial highway or street with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.
32. THROUGH STREET OR THROUGH HIGHWAY - Every highway, street, or portion thereof at the entrance to which vehicular traffic from intersecting highways or streets is required by law to stop before entering or crossing the same and when stop signs are erected.
33. LOCAL STREET OR LOCAL ROAD - A street or road primarily for access to residence, business, or other abutting property.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION CIP2 - ABBREVIATIONS

CIP2.01

SCOPE

A. Whenever in these Contract Documents or Specifications the following abbreviations are used, the intent and meaning shall be interpreted as follows:

1. AA Aluminum Association
2. AAMA Architectural Aluminum Manufacturers' Association
3. AASHTO American Association of State Highway and Transportation Officials
4. ACI American Concrete Institute
5. AFBMA Anti-Friction Bearing Manufacturers' Association
6. AGA American Gas Association
7. AGMA American Gear Manufacturers' Association
8. AISC American Institute of Steel Construction
9. AISI American Iron and Steel Institute
10. AITC American Institute of Timber Construction
11. AMCA Air Moving and Conditioning Association
12. ANSI American National Standards Institute
13. APA American Plywood Association
14. API American Petroleum Institute
15. AREA American Railway Engineering Association
16. ASAE American Society of Agricultural Engineers
17. ASCE American Society of Civil Engineers
18. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
19. ASME American Society of Mechanical Engineers
20. ASTM American Society of Testing and Materials
21. AWI Architectural Woodwork Institute
22. AWPA American Wood Preservers' Association
23. AWPB American Wood Preservers' Bureau
24. AWS American Welding Society
25. AWWA American Water Works Association
26. BHMA Builders' Hardware Manufacturers' Association
27. CBMA Certified Ballast Manufacturers' Association
28. CDA Copper Development Association
29. CISPI Cast Iron Soil Pipe Institute
30. CMAA Crane Manufacturers' Association of America

31.	CRSI	Concrete Reinforcing Steel Institute
32.	Fed. Spec.	Federal Specifications
33.	HI	Hydraulic Institute
34.	HMI	Hoist Manufacturers' Institute
35.	ICBO	International Conference of Building Officials
36.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
37.	IPCEA	Insulated Power Cable Engineer's Association
38.	MMA	Monorail Manufacturers' Association
39.	NACE	National Association of Coatings Engineers
40.	NBMA	National Builders' Hardware Association
41.	NEC	National Electrical Code
42.	NEMA	National Electrical Manufacturers' Association
43.	NESC	National Electric Safety Code
44.	NFPA	National Fire Protection Association
45.	NLMA	National Lumber Manufacturers' Association
46.	NWMA	National Woodwork Manufacturers' Association
47.	OECI	Overhead Electrical Crane Institute
48.	OSHA	Occupational Safety and Health Act (both Federal & State)
49.	PS	Product Standards Sections - U.S. Department of Commerce
50.	RMA	Rubber Manufacturers' Association
51.	SAE	Society of Automotive Engineers
52.	SSPC	Steel Structures Painting Council
53.	TCA	Tile Council of America
54.	TxDOT	Texas Department of Transportation
55.	TEMA	Tubular Exchanger Manufacturers' Association
56.	UBC	Uniform Building Code
57.	UL	Underwriter's Laboratories, Inc.
58.	WWPA	Western Wood Products Association

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP3 – SUMMARY OF WORK

CIP3.01

SCOPE OF WORK

- A. This specification covers the requirements for constructing the *San Gabriel WWTP Rehabilitation* project as shown on the Drawings and specified herein.
- B. The Work is located within the City of Georgetown as described in Section 00300 (Proposal Form) and as shown on the Location Plan included in the Drawings at 1105 N. College St., Georgetown, TX 78626 (San Gabriel WWTP).
- C. Substantial Completion and Final Completion shall be as defined in the General Conditions.
- D. The Work at the San Gabriel WWTP (as shown on the Drawings) includes, but is not necessarily limited to, the following:
 1. Mobilization – Including move-in costs, insurance, bonds, etc.
 2. Complete shop drawing submittal process.
 3. Temporary sedimentation and erosion control.
 4. Installation of 18-inch Influent (INF) piping, 20-inch buried Aeration Basin Influent (ABI) piping, Non-Potable Water (NPW) piping, Sodium Bisulfite (SBS) piping, Drain (DR) piping, concrete flow meter vaults on top of existing Return Activated Sludge (RAS) piping, installation of buried valve(s), and connection to existing tanks.
 - Scope of work includes open trench construction.
 5. Installation of buried electrical ductbank, conduit, and wiring from new Electrical Houses and Generator to existing and new equipment as shown on the Drawings.
 6. Scope of work for all new blower low pressure air (LPA) piping will be above grade with supports from grade as shown on the Drawings.
 7. Testing of new piping systems.
 8. Demolition of pumps, blowers, gates, tanks, and valves as shown on the Drawings.
 9. Modification of existing concrete structures as shown on the Drawings.
 10. Installation of new process equipment including pumps, blowers, diffusers, mechanically-raked bar screen, grit removal equipment, and valves as shown on the Drawings.
 11. Installation of new process instrumentation and control system and modifications to the existing SCADA system.
 12. Electrical and Instrumentation Equipment and Systems Modifications – Consists of power and instrumentation improvements for equipment being furnished.
 13. Site Work – Includes site preparation, grading, seeding, new asphalt and concrete paving, and related work.
 14. Re-vegetation, in accordance with the Edwards Aquifer vegetated filter strip requirements, and Site Restoration.
 15. Demobilization and Clean-up.

WORK SEQUENCE

- A. Perform work in sequence as agreed upon at the Pre-Construction Conference and as noted below and herein.
- B. Regulatory discharge requirements for the plant effluent mandate adequate treatment of discharged wastewater from the plant. The intent of this section is to provide a framework for the Contractor to perform the work in a sequence and manner such that continuous, uninterrupted treatment of wastewater and waste flows are maintained operational throughout the construction period.
- C. Contractor shall coordinate all work sequencing and shutdowns with the Owner's representative and Engineer. Contractor shall provide a 72-hour notice to the Owner prior to any tie-ins and connections to existing system.
- D. Except as noted herein, **no more than half of the WWTP's treatment facilities (aeration basins, clarifiers, and chlorine contact basins) may be shut down at a given time to perform the Work.**
 - 1. In general, the maximum shutdown period will be for 4 hours. All outages will require approval from the Owner and coordination with operation staff.
 - 2. Shutdowns of air service to the entire WWTP will be allowed on a temporary basis not to exceed 4 hours for various tie-ins and other construction requirements.
 - 3. Any equipment necessary to complete the work shall be provided by the Contractor.
- E. The following construction sequencing issues, critical tie-ins, and other considerations shall be taken into account by the Contractor in development of the construction schedule. These items are presented to assist the Contractor and are not all-inclusive.
 - 1. No site improvements, including yard piping installation, conduit installation, etc., shall commence until after the submittals for the proposed improvements have been approved.
 - 2. Installation of Erosion/Sedimentation Controls shall be performed prior to any construction begins.
 - 3. Any Electrical and instrumentation tie-ins and switchovers must be coordinated. Coordinate with Electric Utility for setting of new service and transformer.
 - 4. Any piping tie-ins and switchovers must be coordinated.
 - 5. Complete and receive approval for all applicable submittals.
 - 6. Begin work to provide the following facility modifications which impact the Owner's use of the San Gabriel WWTP Irrigation High Service Pumps, Non-Potable Water Pumps, Headworks fine screen, and Belt Filter Press (and grit system when placed into service). Highly critical uses of NPW include spray water for the fine screen (needed intermittently multiple times per hour) and wash water for the sludge dewatering belt filter press (used several times per week).
 - a. Remove Irrigation Clearwell from service, work with Owner to drain the clearwell and then haul off-site for disposal any debris, grit, and rags from the bottom of the tank.
 - i. Schedule the timing of the clearwell outage with the Owner to minimize impact on the Owner's ability to provide reclaimed water. Typical winter usage ranges from 30,000 to 60,000 gallons per day, while typical summer usage ranges from 300,000 to 700,000 gallons per day.
 - ii. Install Geodesic Dome on clearwell.

- iii. Bring clearwell back into service.
 - b. Interruptions to NPW supply shall be coordinated with the Owner.
 - i. Install geodesic dome and perform clearwell cleaning before the new grit system and aeration basin diffusers are commissioned to avoid bypassing grit removal and fine screening of rags directly into the basins.
 - c. Maintain Owner's use of existing sludge drying beds that will eventually be demolished in this project so that Owner may use these for sludge handling in lieu of Belt Filter Press.
 - d. Construct improvements to increase capacity of Aerated Sludge Holding Tank including new coarse bubble diffusers, piping, and rotary lobe blowers.
- 7. Begin work to replace the San Gabriel WWTP grit system equipment as shown on the Drawings, including demolition of existing equipment, construction of new concrete walls, gates, and weirs.
 - a. Coordinate with Owner and Engineer to maintain half of the grit system in service while work is completed on the other half of the wet well. Provide temporary bypass piping from the elevated headworks to the aeration basins for any periods in which both existing grit basins cannot be used to maintain wastewater delivery to the aeration basins. Refer to Section 331210 "Temporary Bypass Pumping Systems" for flow capacity requirements.
 - b. Installation of buried 20-inch ABI pipe shall be completed on parallel path with grit system replacement work and should be completed prior to bringing new grit system into service.
 - i. Work with Owner to drain Aeration Basins sufficiently low to provide new concrete penetration through the wall.
 - c. Commissioning of grit equipment must be achieved before each Aeration Basin in the Treatment Unit at San Gabriel WWTP may be taken out of service.
- 8. Begin work to replace the San Gabriel WWTP coarse bar screen and modify influent pump station as shown on the Drawings.
 - a. Coordinate with Owner and Engineer to maintain half of the pump station wet well in service while work is completed on the other half of the wet well.
 - b. Provide temporary bypass pumping from a manhole upstream of the coarse bar screen to the elevated headworks for any periods in which it is need to replace gates at the bar screens or for any periods of time when the existing pump station cannot be used to maintain wastewater delivery to the WWTP. Refer to Section 331210 "Temporary Bypass Pumping Systems" for flow capacity requirements.
- 9. Begin work to provide the following facility modifications which impact the Owner's use of the San Gabriel WWTP Treatment Unit:
 - a. Install new Electrical House and variable frequency drives for Pecan Branch Transfer Pumps. Provide to Owner use of this equipment prior to removing any of the Aeration Basins from service.
 - b. Install Multistage Blowers 3 and 4 and associated platforms and Low Pressure Air piping to new fine bubble diffusers and existing RAS air lift pumps in Aeration Basin No. 2.
 - i. Delivery of air from existing Multistage Blowers 1 and 2 (large blowers) to Aeration Basin No. 1 and waste activated sludge (WAS)

- air lift pumps at Aerated Sludge Holding Tank shall be retained at all times.
- ii. Only brief and infrequent shutdowns of the air supply piping from the blowers to the aeration tanks will be allowed. Shutdowns shall be coordinated with the Owner per approved shop drawings.
 - c. Work with Owner to drain Aeration Basin No. 2 and then remove existing coarse bubble diffuser equipment.
 - i. Haul off-site for disposal any debris, grit, and rags from the bottom of the tank in accordance with Section "460200". The Aeration Basins have not been drained for many years and several feet of debris, grit, and sludge accumulation might be found.
 - ii. Install new fine bubble diffusers and piping manifolds in Aeration Basin No. 2.
 - d. Bring Aeration Basin No. 2 back into service using air supply delivered from Multistage Blowers No. 3 and 4.
 - e. Remove large existing blowers and install Multistage Blowers 1 and 2 and associated platforms and Low Pressure Air piping to new fine bubble diffusers and existing RAS air lift pumps in Aeration Basin No. 1.
 - f. Work with Owner to drain Aeration Basin No. 1 and then remove existing coarse bubble diffuser equipment.
 - i. Haul off-site for disposal any debris, grit, and rags from the bottom of the tank in accordance with Section "460200". The Aeration Basins have not been drained for many years and several feet of debris, grit, and sludge accumulation might be found.
 - ii. Install new fine bubble diffusers and piping manifolds in Aeration Basin No. 1.
 - g. Bring Aeration Basin No. 1 back into service using air supply delivered from all new Multistage blowers.
 - h. Work with Owner to drain one of the Chlorine Contact Tanks. Install new baffles and complete concrete repairs and modifications. Bring into service and then complete similar work in other Chlorine Contact Tank.
10. Begin work to install new rotary lobe positive displacement blower and piping for the San Gabriel WWTP Wet Weather Basin as shown on the Drawings.
 11. Begin work on the Sodium Bisulfite storage and feed facility modifications for the San Gabriel WWTP as shown on the Drawings.
 12. Complete and receive approval for all applicable O&M Manuals.
 13. Complete startup of equipment and training of Owner's staff.
 14. Install new paving and receiving dump station at southeast corner of San Gabriel WWTP.
 15. Demolition of sludge drying beds for construction of new concrete roads may not occur until reuse clearwell work and NPW piping improvements are complete.
 16. Complete finish grading.
 17. Achieve Substantial Completion.
 18. Complete seeding to establish grass at all sites.
 19. Remove silt fence and other environmental controls at all sites.

20. Submit specified as-built topographic drawing for the site following completion of all site work.
21. Clean all sites.
22. Achieve Final Completion.

CIP3.03

PROGRESS OF THE WORK

- A. The Work shall be started within 7 days following the effective date of the Notice to Proceed, and the Work shall be executed with such progress as may be required to prevent any delay to the general completion of the project. The Work shall be executed at such times and in or on such parts of the project, and with such personnel, materials, and equipment to assure completion of the Work in the time established by the Agreement.
- B. If the Contractor, for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request to the City and he shall allow ample time for satisfactory arrangements to be made for inspecting the work in progress. The Contractor shall pay the expenses for extra inspection required for work outside regular hours. Normal working hours for this purpose are Monday through Friday 7:00 a.m. to 5:00 p.m. Saturdays are only allowed with prior City approval. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Georgetown.

CIP3.04

CONSTRUCTION SCHEDULE

- A. The Contractor shall, within five (5) days after the effective date of the Notice to Proceed, provide and submit to the City for approval, the Schedule for the project. A complete updated schedule shall be submitted with monthly pay requests. The Schedule shall account for all the work of the Contractor and his Subcontractors and suppliers. In addition to all reasonably important construction activities, the Schedule shall provide for the proper sequence of construction considering the various crafts, purchasing time, submittal approval, material delivery, equipment fabrication, and similar time-consuming factors.
- B. The Schedule shall include, as a minimum, the earliest starting and finish dates, and latest starting and finish dates, and the total float for each task or item. The Contractor shall update (monitor) the schedule as necessary and shall submit to the City a copy of the updated schedule (monthly) at the same time the pay estimate is prepared. The schedule shall contain all of the items of the Periodic Estimate and Pay Schedule.

While the Contractor bears full responsibility for scheduling all phases and stages of the Work to ensure its successful prosecution and completion within the time specified in accordance with all provisions of these Specifications, the Contractor is specifically required to complete fully or complete such stages of work to enable his Subcontractors and suppliers to complete their work within the respective times specified.

- C. If the City determines that operations are falling behind schedule at any time during the construction period, the City may require the Contractor to add to his plant, equipment and/or construction forces, including increases in working hours, in such quantities as are required to bring operations back on schedule. Upon receipt of written communication from the City requiring such addition, the Contractor shall furnish same at no additional cost to the City.

PRECONSTRUCTION CONFERENCE

- A. A Pre-Construction Conference shall be held as soon as possible after Award of Contract and before work is started. The conference will be held at a location selected by the City. The conference will be attended by:
1. Contractor's Office Representative.
 2. Contractor's General Superintendent.
 3. Any subcontractors' or suppliers' representatives whom the Contractor may desire to invite or the City may request.
 4. Engineer's Representatives.
 5. City's Representatives.
 6. Such other individuals that the City may invite.
- B. A suggested format would include but not be limited to the following subjects:
1. Check of required bonds and insurance certifications.
 2. Liquidated damages.
 3. Shop drawing submittal and approval procedure.
 4. Chain of command, direction of correspondence, and coordinating responsibility between Contractors.
 5. Schedule of periodic job meetings for all involved.
 6. Introduction of the key project personnel.
 7. Equal opportunity requirements.
 8. Laboratory testing of material requirements.
 9. Inventory of material stored on site provisions.
 10. Progress estimate and payment procedure.
 11. Discussion of Contractor's Safety program.
 12. Scheduled plan for work requiring interruption of existing operations.
 13. Review of the construction Plans and Specifications.
 14. Discussion of Contractor's storage facilities for the Project.
- C. The City's Representative will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the conference.

CONSTRUCTION MEETINGS

- A. Periodic Construction meetings shall be held at intervals designated by the City, generally monthly to review the progress at the project, submittals, upcoming activities, pay requests, etc. The Contractor is expected to have at least the project Superintendent present for all meetings. Attendance at the meetings shall not be directly paid for but shall be considered subsidiary to the items of the Contract.

- B. In the event the Contractor is 30 minutes late or more or fails to attend a Construction meeting without 48 hours prior notice, the Contractor shall be billed the time for the Engineer(s) to represent the City at \$250.00 per hour up to one (1) hour.

CIP3.07

COORDINATION WITH CITY'S OPERATIONS AND EXISTING FACILITIES

- A. Several parts of the proposed Work under this Contract connect with or into existing facilities. The Contractor shall plan carefully the schedule of that portion of the Work which will affect the existing facilities. Such plans and schedules shall be subject to the approval of the City of Georgetown.
- B. Work which requires shutdown or in any way impedes the operations of existing facilities shall be closely coordinated with the City of Georgetown. A minimum of 72 hours written notice shall be given to the City of Georgetown for all shutdowns and work that will impede treatment operations.
- C. Immediately after the award of a Contract for this Project, the Contractor shall outline and submit a scheduled plan for installation of the work, which requires interruption of operations.

CIP3.08

CONTRACTOR'S USE OF PREMISES

- A. Contractor shall assume full responsibility for security of all materials and equipment stored on the site.
- B. If directed by the City, move any stored items, which interfere with operations of the City, other contractors, or the public.
- C. Obtain and pay for use of additional storage or work areas at no additional cost to the City if needed to perform the Work.
- D. Contractor shall submit to the City for approval a plan of operations, designating proposed areas of the property to be used for his operations, material storage, equipment storage, employee's parking, offices and shops. The area shall effect minimal interference with the present operations.
- E. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- F. Any fence that is damaged or removed by the Contractor will be replaced at the Contractor's expense in like kind, and to the satisfaction of the City.
- G. Contractor shall pick up any trash left by construction forces regularly to maintain a clean and orderly site.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION CIP4 – SITE CONDITIONS

CIP4.01 SCOPE OF WORK

- A. This specification covers the requirements for investigation and verification of site conditions for the Project.

CIP4.02 SUBSURFACE INFORMATION

- A. Subsurface investigations have been made to indicate subsurface conditions at particular locations. A geotechnical test boring program and a geophysical investigation have been completed at the Dove Springs WWTP site and the San Gabriel WWTP site. The boring logs and geophysical logs from those investigations are attached. The Contractor shall be familiar with the subsurface materials and conditions on the project and shall be knowledgeable of how they will affect the work.
- B. Test borings have been made to indicate subsurface materials and conditions only at the particular locations of the borings at the time the borings were made. The same also applies to the geophysical investigation.

CIP4.03 SITE INVESTIGATION AND REPRESENTATION

- A. The Bidder / Contractor acknowledges that he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this Contract.
- B. The Contractor further acknowledges that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information derived from exploratory work, if any, that has been done by the City as presented in the attached geotechnical information, as well as from information presented herein as a part of these Contract Documents. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work. Neither the City nor the Engineer assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the City or the Engineer.
- C. Existing ground profiles shown on the Plans were plotted from field surveys and record documents.

RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Known utilities and structures adjacent to or encountered in the work are shown on the Plans. The locations shown are taken from existing records and the best information available from existing plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the City or the Engineer for their accuracy or completeness.
- B. Neither the City nor its officers or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the work.
- C. The Contractor shall at all times provide unobstructed access to fire hydrants and structures as per Fire Code, underground conduit, manholes, and water or gas valve boxes.
- D. Where the Contractor's operations could cause damage which might result in considerable expense, loss, or inconvenience when his operations are adjacent to or near railway, telegraph, telephone, television, power, oil, gas, water, sewer, irrigation, or other systems, no operations shall be commenced until the Contractor has made all arrangements necessary for the protection of these utilities and services.
- E. The Contractor shall notify all utility offices that are affected by the construction operation at least 15 days in advance of commencing construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.
- F. The Contractor shall be solely and directly responsible to the City and operators of such utility properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage that may result from the construction operations under this Contract.
- G. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, the Contractor shall promptly notify the proper authority and cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair.
- H. The Contractor shall replace, at his own expense, any and all other existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents.
- I. Where existing utility lines or structures are so located as to physically conflict with permanent structures to be constructed under this Contract, the conflicting utility line or structure shall be permanently relocated.
- J. The Contractor shall give immediate notice to the Engineer, the City and the owner of the utility (where applicable) when a physical conflict is determined to exist.
 - 1. Contractor will not be charged contract time for delays caused by unanticipated conflicts.
 - 2. Contractor shall not charge the City of Georgetown for lost time or down time for unanticipated conflicts.

- K. Where existing utility lines or structures are so located as to interfere with the Contractor's prosecution of the work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at the expense of the Contractor.

CIP4.05

INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Plans. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid known possible difficulties.
- B. Protect existing structures from damage, whether or not they lie within the right-of-way or the limits of the easements obtained by the City. Where existing structures must be removed to properly carry out the work, or are damaged during the work, they shall be restored at the Contractor's own expense to at least their original condition and to the satisfaction of the Engineer.
- C. The Contractor may, with the approval of the Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with the Contractor's operations.

CIP4.06

FIELD RELOCATION

- A. During the progress of the work, minor relocations of the work may be necessary. Such relocations shall be made only by direction of the Engineer or the City. If existing structures are encountered that will prevent construction as shown, notify the Engineer before continuing with the work in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. If the Contractor fails to notify the Engineer when an existing structure is encountered and proceeds with the work despite this interference, he shall be responsible for any damage that may occur.

CIP4.07

LAND MONUMENTS

- A. The Contractor shall preserve or replace any existing Federal, State, County, City, and private land monuments encountered.
- B. Any damaged or destroyed monuments shall be replaced at the sole expense of the Contractor as designated by the controlling authority of the Entity.

CIP4.08

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION CIP6 – CONTROL OF WORK

CIP6.01 SCOPE OF WORK

- A. This specification covers the requirements for exercising control of work performed on the Project.

CIP6.02 AUTHORITY OF ENGINEER OR INSPECTOR

- A. The work will be done in accordance with the Contract, Plans and Specifications. The Engineer or Inspector will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed and the interpretations of the Plans and Specifications. His decisions will be final, and he will have executive authority to enforce and make effective such decisions and orders.

CIP6.03 CONFORMITY WITH PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. All work performed and all materials furnished shall be in reasonable close conformity with the lines, grades, cross sections, dimensions, details, gradations, physical and chemical characteristics of materials in accordance with tolerances shown on the Plans or indicated in the Specifications and Special Provisions. The limits establishing reasonable close conformity will be as defined in these items of the contract.
- B. In the event the City finds that the work performed or the materials used are not within reasonable close conformity with the Plans, Specifications and Special Provisions, the affected material or product shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.
- C. Deviations from the Plans and approved working drawings as may be required will in all cases be determined by the City and authorized in writing. Before final acceptance of the project is issued by the City, the Contractor shall provide the City with a set of record drawings for the project certified by the Engineer of record.

CIP6.04 COORDINATION OF PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. The Specifications, accompanying Plans, Special Provisions, and Supplemental Agreements are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be cooperative and to describe and provide for a complete work. In cases of disagreement, figured dimensions shall govern over scaled dimensions, the Plans shall govern over Specifications, and Special Provisions shall govern over both Specifications and Plans.

CIP6.05 AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these

Specifications, nor to approve or accept any portion of work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the work.

CIP6.06

PROJECT

- A. The Contractor shall furnish plant and/or equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract Documents. If at any time such plant or equipment appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character or increase the plant and equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of work and rate of progress required.

CIP6.07

PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by written permission of the respective landowner.

CIP6.08

PIPE LOCATIONS

- A. Pipelines shall be located substantially as indicated on the Plans, but the Engineer and the City reserve the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Plans, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

CIP6.09

OPEN EXCAVATIONS

- A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight. The Contractor shall take precautions, such as fences and barricades, to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles, which could be dangerous to the public, shall be well lighted at night. All trenches shall conform to the requirements of OSHA.

CIP6.10

TEST PITS

- A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer or the City. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer and the City.

CIP6.11

MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street is received in writing from the proper authority, all excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards; Contractor shall prepare and submit a traffic control plan, shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer and the City.
- B. Detours around construction will be part of the Contractor's traffic control plan and is subject to the approval of the City and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the City.
- C. The Contractor shall take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

CIP6.12 BLASTING

- A. No blasting shall be allowed unless approved in writing by the City of Georgetown.

CIP6.13 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better than existing before the damage was done, or he shall make good the damage in some other manner acceptable to the Engineer and the City.

CIP6.14 MAINTENANCE OF FLOW

- A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and the City well in advance of the interruption of any flow.

CIP6.15 COOPERATION WITHIN THIS CONTRACT

- A. The Contractor shall cooperate with Subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the Contractor and his Subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer or the City.

CIP6.16 CLEANUP

- A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. The Contractor shall dispose of all rubbish resulting from the construction work and, at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other

refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

CIP6.17

FINAL INSPECTION

- A. Whenever the work provided for in, and contemplated under, the contract has been satisfactorily completed, the City will make the "Final Inspection". If the work is found to be satisfactory, the Contractor will be notified in writing of the acceptance of the same. The City will require a Certificate of Completion and Final Acceptance from the Inspector before any building, electric or plumbing permits will be issued or any City utilities provided. No such Certificate will be issued until all monuments have been set and record drawings reviewed by the Engineer of Record are provided to the City. If items are found in need of repair or completion, a final punch list will be generated and the items shall be completed by the Contractor. The City will inspect the punch list items one time following their completion. Any subsequent inspections due to inadequate repair or completion of the punch list items shall be paid for by the Contractor or Developer at \$200.00 per inspection, up to two (2) hours. Any additional time will be paid by the Contractor or Developer at a rate of \$200.00 per hour.
- B. Final acceptance of the Project or Development does not relieve the Contractor or Developer of the responsibility of insuring all work shown on the Plans has been completed. If any portion of the work is found at a later date to be inferior or incomplete, the Contractor or Developer shall replace or complete the work at no expense to the City.

CIP6.18

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP7 – CONTROL OF MATERIALS

CIP7.01 SCOPE OF WORK

- A. This specification covers the requirements for exercising control of materials used on the Project.

CIP7.02 SOURCES OF SUPPLY AND QUALITY OF MATERIALS

- A. The source of supply of each of the materials shall be approved by the City before any deliveries and at the option of the City, may be sampled and tested for determining compliance with the governing Specifications by the City before delivery begins. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other approved sources. Only materials conforming to the requirements of these Specifications and approved by the City shall be used in the work. All materials being used are subject to inspection or test at any time during their preparation or use. Any materials which have been tested and accepted at the source of supply may be subjected to a check test after delivery and all materials which, when retested, do not meet approval or have in any way become unfit for use shall not be used in the work.
- B. Throughout these Specifications where reference is made to ASTM, AASHTO or bulletins of the Texas Department of Transportation for the quality of materials or sampling and testing, the most current standard, tentative standard or bulletin issued prior to the date of the proposal shall govern.

CIP7.03 SAMPLES AND TEST

- A. All materials, before being incorporated in the work, shall be inspected, tested and approved by the City and any work in which materials are used without prior test and approval or written permission of the City may be ordered removed and replaced at the Contractor’s expense. The Contractor shall be responsible for and pay for all charges of testing laboratories for services in conjunction with initial tests made on all imported materials to the project site including but not limited to embedment materials, fill materials, backfill materials, select material, crushed limestone base, sub-base, concrete, steel, wood forms, liquid asphalt, aggregate, water, cement, guard rail etc. Sampling and testing of all materials, on the project site will be coordinated by the Contractor and paid for by the City. The selection of the method of test shall be designated by the City. Where tests are required, other than those made in the laboratory, for the purpose of control in the manufacture of a construction item, the Contractor will be required to furnish such facilities and equipment as may be necessary to perform the tests and inspection and shall be responsible for calibration of all test equipment required. When requested, the Contractor shall furnish a complete written statement of the origin, composition, and/or manufacture of any or all materials that are to be used in the work. Testing of all materials and work shall conform to the Texas Department of Transportation “Manual of Testing Procedures” which outlines testing methods and procedures. Other Texas Department of Transportation Bulletins shall apply.

CIP7.04

PAYMENT

- A. No separate payment will be made for work performed under this section of the specifications and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP8 – LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

CIP8.01 SCOPE OF WORK

- A. This specification covers the requirements for complying with all Federal, State, and local laws, ordinances, and regulations, which in any manner affect the conduct of the work on the Project.

CIP8.02 LAWS TO BE OBSERVED

- A. The Contractor shall make himself familiar with and at all times shall observe and comply with all Federal, State, and local laws, ordinances, and regulations which in any manner affect the conduct of the work and shall indemnify and save harmless the City and its representatives against any claim arising from the violation of any such law, ordinance, or regulation, whether by himself or by his employees.

CIP8.03 PERMITS, LICENSES AND TAXES

- A. The Contractor shall procure all permits and licenses, pay all charges, fee and taxes, and give all notices necessary and incident to the due and lawful prosecution of the work.

CIP8.04 RESTORATION OF SURFACES OPENED BY PERMIT

- A. The Contractor shall not allow any party to make an opening in the highway or street unless a duly authorized permit signed by the owner of the facility is presented. Until the acceptance of the work, the Contractor shall make all necessary repairs in the roadway where openings have been made by due authority.

CIP8.05 PUBLIC SAFETY AND CONVENIENCE

- A. The safety of the public and the convenience of traffic shall be regarded as of prime importance. Unless otherwise shown on the Plans or except as herein provided, all portions of the highway and street shall be kept open to traffic. It shall be the entire responsibility of the Contractor to provide for traffic along and across the highway and streets as well as for ingress and egress to private property all as specified herein, as shown on the Plans or as directed by the City.
- B. The Contractor shall plan and execute his operations in a manner that will cause the minimum interference with traffic. The Contractor shall secure the City's approval of his proposed plan of operation, sequence of work and methods of providing for the safe passage of traffic before it is placed into operation. If at any time during construction, the approved plan does not accomplish the intended purpose, due to weather or other conditions affecting the safe handling of traffic, the Contractor shall immediately make necessary changes in accordance with the latest version of the Texas Manual on Uniform Traffic Control Devices (TMUTCD) to correct the unsatisfactory conditions.
- C. If due to rains or other reasons, the shoulders, slopes and ditches become unsatisfactory for handling traffic, construction operations shall be suspended and the base course or surface area shall be opened to traffic. Where the Specifications require that traffic be carried over or along

the proposed work, construction operations shall be so prosecuted and new material so kept that placement and spreading will allow the passage of traffic in comfort and safety.

- D. Where an Asphalt Surface Treatment is placed for the full width in an operation, traffic shall be carried on the shoulder slopes and ditches where appropriate. During the operation of placing asphalt and aggregate, the surface or pavement shall not be closed to traffic for a period of more than 45 minutes.
- E. During construction of proposed structures, unless otherwise shown on the Plans, the Contractor shall provide and maintain detours including temporary structures or crossovers of adequate structural design as may be required for the safety and convenience of the traffic.
- F. At night or otherwise, all equipment not in use shall be stored in such manner and such locations as not to interfere with the safe passage of traffic. The Contractor shall provide and maintain flagmen at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and Contractor's personnel, and as directed by the City. Flagmen shall have a sense of responsibility for the safety of the public and the workers, adequate training in safe temporary traffic control practices, average intelligence, good physical condition, including sight, mobility, and hearing, mental alertness and the ability to react in an emergency, courteous but firm manner, and a neat appearance. When directing traffic, flagmen shall use the standard attire, flags and signals and follow the flagging procedure set forth in "Instructions to Flagmen" published by the Texas Department of Transportation.

CIP8.06

BARRICADES AND DANGER, WARNING AND DETOUR SIGNS

- A. The Contractor shall place and maintain in good condition, standard barricades and warning signs at each end of the project and at other locations therein as called for on the Plans or as called for in the Contractor's approved plan of operation. The signs shall be of standard design as shown on the Plans and in accordance with Texas Department of Transportation Standards.
- B. All barricades and signs remaining in place at night and all points of hazard to traffic shall be either retro-reflective with a material that has a smooth, sealed outer surface or illuminated by lights to show the same shape and similar color both day and night. Signs which refer to construction operations which do not apply after work has ended for the day, shall be moved to points out of the clear zone that are not visible to traffic until construction is resumed.
- C. The Contractor may provide special signs not covered by the Plans to protect the traveling public against special conditions or hazards, provided however, that such signs are first approved by the City.
- D. Upon completion of the work, all signs and evidences thereof shall be removed by the Contractor.

CIP8.07

PROJECT IDENTIFICATION SIGNAGE

- A. Project identification signage shall be in accordance with Section CIP15 - PROJECT IDENTIFICATION SIGNAGE. This does not apply to private development Projects.

CIP8.08

USE OF EXPLOSIVES

- A. When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, and all storage places shall be marked clearly, "DANGEROUS - EXPLOSIVES". The method of storing and handling explosives and highly flammable materials shall conform with Federal and State laws and regulations. **The use of explosives must be approved in writing by the City prior to any use.**
- B. In advance of doing any blasting work, involving the use of electric blasting caps within 200 feet of any railroad track, the Contractor shall give at least 24 hours advance notice to the nearest Roadmaster, Section Foreman, Agent, Signal Maintainer or Telegraph Operator with the request that his Superintendent be advised immediately of the pending use of explosives.

CIP8.09

PROTECTION OF ADJOINING PROPERTY

- A. The Contractor shall take proper measures to protect the adjacent or adjoining property which might be damaged by any process of construction, and in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Contractor, he shall restore at his own expense the damaged property to a condition equal or better than that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.

CIP8.10

RESPONSIBILITY FOR DAMAGE CLAIMS

- A. The Contractor shall save harmless the City from all suits, actions or claims brought on account of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work by the Contractor, or from any claims or amounts arising or recovered under the "Workmen's Compensation Laws" or any other laws. He shall be responsible for all damage or injury to property of any character occurring during the prosecution of the work resulting from any act, omission, neglect, or misconduct on his part in the manner or method of executing the work; or from his failure to properly execute the work; or from defective work or materials. He shall not be released from such responsibility until all claims have been settled and suitable evidence to that effect furnished the Council.
- B. The Contractor's attention is directed to the fact that pipelines and other underground installations as may be shown on the Plans have been taken from the best available information. There may be other pipelines or installations. The Contractor shall save harmless the City from any and all suits or claims resulting from damage by his operations to any pipeline or underground installation.

CIP8.11

CONTRACTOR'S RESPONSIBILITY FOR WORK

- A. Until the final acceptance of the work by the City as evidenced in writing, it shall be under the charge and care of the Contractor. Contractor shall rebuild and make good at his own expense all injuries and damages to the work occurring before its completion and acceptance. In case of suspension of work for any cause, the Contractor shall be responsible for the preservation of all materials. He shall provide suitable drainage of the roadway and shall erect temporary structures where required. The Contractor shall maintain the roadway in good and passable condition until final acceptance.
- B. Wherever, in the opinion of the City, any roadway or portion thereof is in suitable condition for travel, it shall be opened to traffic, as may be directed, and such opening shall not be held

to be in any way the final acceptance of the roadway or any part of it or as a waiver of any of the provisions of the Contract. Where it is considered by the City to be in the public interest, any substantially completed roadway or portion thereof may be opened to traffic.

CIP8.12

PERSONAL LIABILITY OF PUBLIC OFFICIALS

- A. In carrying out the provisions of the contract or in exercising any power or authority granted thereunder, there shall be no liability upon the City or its authorized assistant, either personally or otherwise, as they are agents and representatives of the City.

CIP8.13

PROSECUTION OF WORK

- A. Prior to beginning construction operations, the Contractor shall submit to the City a chart or brief outlining the manner of prosecution of the work that he intends to follow in order to complete the Contract. Before any work is started on the project or development, a Pre-Construction Conference, shall be held between the City, Contractor, Developer and any other interested parties.

CIP8.14

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP9 – ENVIRONMENTAL PROTECTION PROCEDURES

CIP9.01

SCOPE OF WORK

- A. This specification covers the requirements for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.
- C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area. Specific requirements are specified in Section G6 - SEDIMENTATION AND TEMPORARY EROSION CONTROL.
- D. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Texas Commission on Environmental Quality (TCEQ), and U.S. EPA.

CIP9.02

SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including descriptions of any special operations required, temporary roads and embankments, and all other pertinent data to illustrate conformance to the specification found within.

CIP9.03

APPLICABLE REGULATIONS

- A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

CIP9.04

NOTIFICATIONS

- A. The Engineer and/or City will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. The Contractor shall, after receipt of such notice from the Engineer or from the regulatory agency through the Engineer,

immediately take corrective action. Such notice, when delivered to the Contractor or his/her authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the City may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

CIP9.05

IMPLEMENTATION

- A. Prior to commencement of the work, the Contractor shall meet with the City to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program. All environmental and pollution control features shall be in place prior to any construction.
- B. Remove temporary environmental control features, when approved by the Engineer, and incorporate permanent control features into the Project at the earliest practical time.

CIP9.06

PROTECTION OF WATERWAYS

- A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
- B. Contractors are specifically cautioned that disposal of materials into any waters of the State must conform with the requirements of the TCEQ, and an applicable permit from the U.S. Army Corps of Engineers.
- C. The Contractor shall be responsible for providing holding ponds or an approved method which will handle, carry through, or divert around his work all flows, including storm flows and flows created by construction activity, so as to prevent silting of waterways or flooding damage to the property or adjacent properties.
- D. The Contractor is responsible for researching the need for a U.S. EPA NPDES permit for the construction site. If one is required, the Contractor is responsible for obtaining the permit and for monitoring the site per the permit requirements until final completion.

CIP9.07

DISPOSAL OF EXCESS EXCAVATION AND OTHER WASTE MATERIALS

- A. Excess excavated material not required or suitable for backfill and other waste material must be disposed of at sites approved by the City and Engineer.
- B. Unacceptable disposal sites include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.
- C. The Contractor may make his own arrangements for disposal subject to submission of proof to the Engineer that the Owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency and submission of a haul route plan including a map of the proposed route(s).
- D. The Contractor shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for

disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

CIP9.08

USE OF CHEMICALS

- A. All chemicals used during project construction or furnished for project operation whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of the U.S. Environmental Protection Agency or the U.S. Department of Agriculture or any other applicable regulatory agency. Use of all such chemicals and disposal of residues shall be in conformance with the Manufacturer's instructions.
- B. Any oil or other hydrocarbon spilled or dumped during construction must be excavated and completely removed from the site prior to final acceptance. Soil contaminated by the Contractor's operations shall become the property of the Contractor, who will bear all costs of testing and disposal.
- C. Before a Contractor commences work, the following steps shall be completed:
 - 1. The City will inform the Contractor of his rights under the Texas Hazards Communication Act.
 - 2. The City will provide a copy of the Chemical List giving the hazardous chemicals to which the Contractor, his employees and agents may be exposed to on the Project site.
 - 3. The City will provide copies of all Material Safety Data Sheets (MSDSs) to the Contractor for the hazardous chemicals which he may be exposed to on the Project site.
 - 4. The City will inform the Contractor of his obligation to inform his employees and agents of each of the above requirements.
 - 5. The Contractor shall provide MSDSs for all hazardous chemicals he may bring onto the project site that the City's employees may be exposed to.
 - 6. The Contractor shall sign a Contractor Acknowledgment certifying that he/she has received the information provided by the City on hazardous chemicals and maintain the Acknowledgment with the original Contract.

CIP9.09

EROSION CONTROL

- A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures such as siltation basins, silt fences, rock berms, hay check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Flow of surface water into excavated areas shall be prevented. Ditches around the construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

PROTECTION OF STREAMS

- A. Care shall be taken to prevent, or reduce to a minimum, any damage to any stream from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such waters will be diverted through a settling basin or filter before being directed into the streams.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a Contingency Action Plan approved by the TCEQ. Contractor shall submit two (2) copies of approved contingency plans to the Engineer.
- D. Water being flushed from structures or pipelines after disinfection, with a chlorine residual of 2 mg/l or greater, shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.

PROTECTION OF LAND RESOURCES

- A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the Project. Confine all construction activities to the appropriate areas shown on the Plans.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them in accordance with Section G6 - SEDIMENTATION AND TEMPORARY EROSION CONTROL. Monuments and markers shall be protected similarly before beginning operations near them.
- D. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition. The Engineer or the City will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.
- E. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than one inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.

- F. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer or the City, shall be immediately removed and replaced.
- G. The locations of the Contractor's storage, and other construction buildings, required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Plans and shall require written approval of the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Plans showing storage facilities shall be submitted for approval of the Engineer or the City.
- H. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he/she shall submit the following for approval at least 10 days prior to scheduled start of such temporary work.
 - 1. A layout of all temporary roads, excavations and embankments to be constructed within the work area.
 - 2. Details of temporary road construction.
 - 3. Plans and cross sections of proposed embankments and their foundations, including a description of proposed materials.
 - 4. A landscaping drawing showing the proposed restoration of the area. Removal of any trees and shrubs outside the limits of existing clearing area shall be indicated. The drawing shall also indicate location of required guard posts or barriers required to control vehicular traffic passing close to trees and shrubs to be maintained undamaged. The drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the Contractor's approved drawings shall be made only with the written approval of the Engineer. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.
- G. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess waste materials, or any other vestiges of construction as directed by the Engineer or the City. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in Section G7- LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL, or as approved by the Engineer or the City.
- H. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

CIP9.12

PROTECTION OF AIR QUALITY

- A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control. The Contractor will be required to maintain all excavations, embankment, subgrade, road bed, base course stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which could

cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.

- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer or the City.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer or the City.

CIP9.13

MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. During the life of this Contract, the Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

CIP9.14

NOISE CONTROL

- A. The Contractor shall make every effort to minimize noises caused by his/her operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with State and Federal regulations.

CIP9.15

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP11 – TRENCH SAFETY REQUIREMENTS

CIP11.01

SCOPE OF WORK

- A. This specification covers the requirements to plan, design, construct, install, maintain, monitor, modify as necessary, and remove upon completion, a Trench Safety System as specified herein.
- B. The requirements of this Section apply to all trenches which equal or exceed a depth of five (5) feet, measured from the ground surface at the highest side of the trench to the trench bottom.
- C. All applicable and non-conflicting portions of Section G4- TRENCHING, BACKFILLING AND COMPACTION apply as appropriate.

CIP11.02

SUBMITTALS

- A. Within 30 days after the Notice to Proceed, but not less than 10 calendar days prior to execution of any trench excavation operations, the Contractor shall submit a site specific Trench Safety System Conformance Affidavit stating that operations will be conducted in full conformance with the OSHA Standards.
 - 1. The Conformance Letter shall also describe the Trench Safety System techniques proposed to be used on the Project.
 - 2. Specific references to the applicable OSHA Standards sections shall be included for each technique to be used.
- B. The Trench Safety System Plan shall be in writing, site specific and sufficiently detailed and clear to be understandable and usable by all personnel who will be executing, supervising and witnessing the trenching operations. A copy of the Trench Safety System Plan shall be available at the site of trenching operations at all times.
- C. If borings and/or detailed geotechnical analyses are required to develop the Trench Safety System Plan, they shall be executed by the Contractor at his cost.
- D. For trenches having depths greater than the various limits given in the OSHA Standards (8, 12 or 20 feet, depending on the techniques used), a site specific protective system shall be designed by a Registered Professional Engineer, registered in the State of Texas experienced in soil mechanics and structural design. The design shall be signed, sealed and dated by the Professional Engineer, and it shall identify those specific locations where the design is applicable.

CIP11.03

GENERAL

- A. All materials and products incorporated into the Trench Safety System shall be suitable for their intended uses; shall meet all design criteria and parameters used by the Trench Safety System designer; and shall meet all applicable requirements of OSHA Standards.

CIP11.04

METHODS OF PROVIDING FOR TRENCH SAFETY

- A. Protective systems referenced in this Section shall be as defined and described in 29 CFR 1962.652, "Requirements for Protective Systems."
- B. It is the duty, responsibility and prerogative of the Contractor to determine the specific applicability of a proposed Trench Safety System for each field condition encountered on the Project. Contractor specifically holds the City, Engineer, and any of their designated representatives harmless in any actions resulting from the failure or inadequacy of the Trench Safety System used to complete the Project.
- C. Unless otherwise noted on the drawings or excluded below, Sloping/Benching, Trench Shielding with

trench boxes, and/or Sheeting/Shoring/Bracing protective systems may be used on this Project.

- D. Restrictions on the use of the various protective systems for this Project are as follows:
1. Sloping or Benching. Allowed with prior approval from the City.
 2. Trench Shields/Boxes. No restrictions.
 3. Sheeting/Shoring/Bracing. No restrictions.

CIP11.05

INSPECTION DUTIES OF CONTRACTOR

- A. Provide a Competent Person, as defined in the OSHA Standards, to make frequent inspections of the trenching operations and the Trench Safety System in full conformance with the OSHA Standards.
- B. If evidence of a possible cave-in or landslide is apparent, all work in the trench shall immediately cease and not be resumed until all necessary precautions have been taken to safeguard personnel entering the trench.
- C. In an emergency situation, which may threaten or affect the safety or welfare of any persons or properties, the Contractor shall act at his discretion to prevent possible damage, injury or loss. Any additional compensation or time extension claimed for such actions shall be considered in view of the cause of the emergency and in accordance with the General Conditions.

CIP11.06

MEASUREMENT AND PAYMENT

- A. Payment for the Trench Safety Plan shall be on a Lump Sum price basis, the Lump Sum price being as given in the Bid Proposal.
- B. Payment for the Trench Safety Plan Implementation shall be on a unit price basis, the unit price being as given in the Bid Proposal, and the unit of measure being linear feet of trench and/or square foot of bore pit or structure, without regard to whether specific trench safety precautions are required or used for the trench reach being measured.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP12 – TESTING OF PIPELINES AND MANHOLES

CIP12.01

SCOPE OF WORK

- A. This specification covers the requirements to perform ex-filtration testing and deflection testing of gravity pipelines and to perform pressure and leakage testing of pressure pipelines.

CIP12.02

SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including a description of the deflection test procedure for flexible pipe greater than 27-inches in diameter, video inspection of gravity wastewater lines, and all other pertinent data to illustrate conformance to the specification found within.

CIP12.03

GENERAL

- A. The entire length of the installed gravity line and the force main shall be field tested for water tightness. Gravity wastewater lines shall be video taped by camera.
- B. Hydrostatic pressure and leakage tests shall be made on all pressure pipelines carrying wastewater or water.
- C. All labor and equipment, including, but not limited to test pump with regulated by-pass meters and gauges required for conducting pipeline tests, shall be furnished by the Contractor. The Contractor shall furnish equipment and necessary piping as required to transport water used in testing from source to test location.
- D. Time and sequence of testing shall be scheduled by the Contractor, subject to observation and approval by the City. The Contractor shall provide adequate labor, tools and equipment to operate valves and to locate and repair any leaks discovered during the initial filling of the pipeline prior to actual testing or during the course of the tests.

CIP12.04

CLEANING

- A. At the conclusion of the work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Engineer will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired, and/or replaced by the Contractor at his expense.

CIP12.05

TEST PROCEDURES FOR GRAVITY PIPELINES, FORCE MAINS AND MANHOLES

- A. Scope: After sewers and manholes have been installed and backfilled, subject newly laid gravity lines and manholes to a leakage test. Contractor to furnish all labor, materials, tools and equipment to test lines. Take such precautions as required to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at Contractor's expense. Conduct test in presence of Engineer or designated City Representative.
- B. Test Procedures for Leakage Test of Gravity Sewer: Contractor, at his option, may test lines by hydrostatic or low pressure air test as specified below. However, the Engineer may direct a specific test be performed in specified areas of the Project.
- C. Infiltration or Exfiltration Test (for Gravity Sewer)
1. Preparation: Seal ends of line section being tested with water tight plugs, equipped with pipe

riser inserted and braced in the inlet of the manholes. Fill section with water 24-hours prior to start of test. Fill slowly from downstream manhole in test section so that no air is trapped in the line. Leave outlets of stacks and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe. After completion of satisfactory test, remove lengths of pipe added for test.

2. Duration of Test: Test for 24-hours. Minimum head of either two (2) feet measured above the crown, inside pipe at upper end of section or four (4) feet measured above trench water table, whichever is higher, so that a net positive of two (2) feet TCEQ is used for testing.
3. Allowable Leakage: Allowable leakage or exfiltration in any individual section under construction shall not exceed 10 gallons per inch of inside diameter per mile of pipe per 24 hours.

D. Low Pressure Air Test

1. Preparation: Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water or by use of water jet cleaning equipment. After manhole to manhole reach of pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psig. Add air slowly to the section under test until the internal pressure of 4.0 psig is obtained. Allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
2. Duration of Test and Allowable Leakage

Decrease pressure to 3.5 psig and start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times are indicated in seconds and shall be computed by the following equation:

$$T = (0.085 \times D \times K) / Q$$

T = time for pressure to drop 1.0 pound per square inch gauge in seconds
 K = 0.000419 x D x L, but not less than 1.0
 D = average inside diameter in inches
 L = length of line of same pipe size being tested, in feet
 Q = rate of loss assume 0.0015 cubic feet per minute per square foot internal surface shall be used

Since K value of less than 1.0 shall not be used, there are minimum times for each pipe diameter as outlined below:

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
30	1700	80	21.369(L)
33	1870	72	25.856(L)
36	2040	66	30.771(L)

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge shall be 10 seconds.

E. Test Procedures for Hydrostatic Test for Manholes

1. Manholes shall be tested for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, or other methods acceptable to the City. If a manhole fails a leakage test, the manhole must be made water tight and retested. The maximum leakage for hydrostatic testing shall be in accordance with TCEQ §217.57 Testing Requirements for Installation of Gravity Collection System Pipes. Alternative test methods must 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 one (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.

F. Test Procedures for Vacuum Testing Manholes

1. In lieu of the hydrostatic exfiltration test, manholes may be tested by vacuum. Manholes tested by vacuum shall be performed by the Contractor in compliance with these specifications.
2. Manholes shall be tested after installation of all connections (existing and/or proposed) in place. All lift holes shall be plugged with an approved non-shrink grout and all drop connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond the drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches of mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time as shown in the following table. If the drop in the level is less than one (1) inch of mercury (final vacuum of nine (9) inches of mercury), the manhole will have passed the vacuum test. The required test time shall be 120-seconds.
3. Manholes which have a final vacuum of nine (9) inches of mercury after the time indicated will be accepted. Any manhole which fails the vacuum test as described above shall be repaired with an approved non-shrink grout or other material acceptable to the Engineer and the City based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made.

G. Exfiltration Test

1. Preparation: Seal ends of manhole being tested with watertight plugs. Fill manhole 24-hours prior to start of test. Manholes to be filled to top of manhole cone section.

2. Duration of Test: The test shall be performed for a 24-hour duration.
3. Allowable Leakage: No leakage is allowed. The water elevation shall be the same at beginning and end of test period.

H. Deflection Testing

1. Deflection tests shall be performed on all flexible pipes. For pipes with inside diameters less than 27-inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter of 27-inches and greater, the Contractor shall submit to the Engineer the proposed method, with which shall provide a precision of \pm two tenths of one percent (0.2%) deflection, for review and approval by the Texas Commission on Environmental Quality. The test shall be conducted after final backfill has been in place at least 30 days in the presence of a representative of the City's Utilities Department. No pipe shall exceed a deflection of five percent (5%). If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. Test shall be performed without mechanical pulling devices.
 2. Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter of the pipe minus two minimum wall thickness for O.D. controlled pipe and the average inside diameter for the I.D. Controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
 3. Mandrel Design: The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.
 4. Method Options: Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Commission on Environmental Quality for review and approval. Mandrels with removable legs or runners may also be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Commission on Environmental Quality for review and approval.
- I. Repairs of Lines: Remove and replace or make approved corrective repairs to any section of line or manhole which has leakage that exceeds above amounts. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. Individual leaks will ordinarily be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations or immediately after water leakage is emptied from sewer.
- J. Retest: Sewers and/or manholes failing to meet requirements of leakage test will, after repair by Contractor, be tested again for leakage. No sewer or manhole will be accepted until leakage is less than allowable amount.

K. Video Inspection

1. The use of a television camera for inspection prior to placing the sewer in service will be required. Video inspection is at the cost of the Contractor, and copies of the DVD will be presented to the City prior to final acceptance. One (1) copy of the DVD shall be submitted to the City.
2. Post construction video of the gravity wastewater lines will be evaluated on a case-by-case basis for acceptance. Preparation for video taping of wastewater line shall be as follows:

- a. Flush and clean the gravity wastewater line prior to video taping.
- b. The videotape shall display the station, in accordance with the Plans and Standards, and counter on the screen. Manhole numbers and stations shall correspond to the contract documents.
- c. If debris is evident in the line during the video, the line will be flushed and cleaned to allow a clean video.
- d. All manholes will be identified at the beginning and end of the video corresponding to contract documents with upstream and downstream ends identified.
- e. Additional video inspections shall be performed prior to completion of one-year warranty period and submitted on DVD.

L. Force Main

1. Force main testing shall be in accordance with TCEQ §217.68 Force Main Testing.

CIP12.06

TEST PROCEDURES FOR PRESSURE PIPELINES

A. General

1. After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure specified below for that particular type of pipe. The duration of the hydrostatic test shall be at least two (2) hours. Unless otherwise specified or noted on the Plans. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.
2. Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the Contractor shall install, at his own expense, corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the Contractor. Replacement shall be with sound material and the test shall be repeated until satisfactory to the City.

- B. Special Requirements: Where any section of pipeline is provided with concrete reaction blocking, the hydrostatic pressure shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.

- C. Leakage Test: A Leakage Test will be conducted on each valved section over the entire Project. The leakage test shall be at 150 psi for at least four (4) hours. Fire lines shall be tested at 200 psi for two (2) hours with 0 loss.

D. Allowable Leakage

1. The allowable hydrostatic leakage rate shall be based on the following formula:
 Fire lines 0 loss

$$L = SD\sqrt{P/148,000}$$
 L = testing allowance in gallons per hour
 S = length of pipe tested in feet
 D = nominal diameter of the pipe in inches
 P = average test pressure during the hydrostatic test in pounds per square inch (gauge)

Table 6A
Hydrostatic testing allowance per 1,000 ft of pipeline* - *gph*[†]

Average Test Pressure		Nominal Pipe Diameter, in.															
psi	(kPa)	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60
300	(2,070)	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62	6.32	7.02
275	(1,900)	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38	6.05	6.72
250	(1,720)	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13	5.77	6.41
225	(1,550)	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86	5.47	6.08
200	(1,380)	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59	5.16	5.73
175	(1,210)	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22	3.75	4.29	4.83	5.36
150	(1,030)	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98	3.48	3.97	4.47	4.97
125	(860)	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72	3.17	3.63	4.08	4.53
100	(690)	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43	2.84	3.24	3.65	4.05
75	(520)	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40	1.76	2.11	2.46	2.81	3.16	3.51
50	(340)	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15	1.43	1.72	2.01	2.29	2.58	2.87

* If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

[†] Calculated on the basis of Eq. 1.

- a. These formulas are based on a testing allowance of 11.65 gpd/mi/in. (1.079 L/d/km/mm) of nominal diameter at a pressure of 150 psi (1,034 kPa).
 - b. 5.2.1.6.1 Testing allowance at various pressures is shown in Tables 6A and 6B.
 - c. 5.2.1.6.2 When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/h/in. (1.2 mL/h/mm) of nominal valve size shall be allowed.
 - d. 5.2.1.6.3 When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
 - e. 5.2.1.7 Acceptance of installation. Acceptance shall be determined on the basis of testing allowance. If any test of laid pipe discloses a testing allowance greater than that specified in Sec. 5.2.1.6, repairs or replacements shall be accomplished in accordance with the specifications.
 - f. 5.2.1.7.1 All visible leaks are to be repaired regardless of the allowance used for testing.
2. If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the specified allowance. All known leaks, irregardless of this test, shall be repaired.
- E. Pressure Test: After satisfactorily completing the leakage test, each valved section over the entire project, shall be tested at 200 psi for a sufficient period (approximately 10 min) to discover all leaking or defective materials and/or workmanship.
- F. Disinfecting Water Mains: The Contractor shall disinfect all water mains before the new facilities are placed into service. Disinfection must be performed in accordance with AWWA C651, latest revision and water samples must be submitted to a laboratory approved by the Texas Department of Health. Sample must be collected by the Contractor or his representative in the presence of the City or his representative. The Contractor shall be responsible for delivering the samples to an approved laboratory for testing. Sample results must indicate the facility is free of microbiological contamination before it is placed into service. It shall be the Contractor's responsibility to obtain a current copy of AWWA C651 to determine the correct forms of chlorine for disinfection, the basic disinfection procedure, preventive and corrective measures during construction, methods of chlorination, final flushing procedures, procedures for bacteriological tests, procedures for re-disinfection and disinfection procedures when cutting into existing mains. The Contractor, at its expense, will supply the concentrated chlorine disinfecting material, the City's personnel will supervise and direct the overall sterilization procedure. The Contractor, at his own expense, shall provide all other equipment, supplies and necessary labor to perform the sterilization under general supervision by the City.

G. General

1. All valves shall be arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The new pipeline shall then be completely filled with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of chlorine as prescribed in AWWA C651.
2. Unless otherwise identified, all quantities called for herein refer to measurements by the testing procedures in the current edition of "Standard Methods of Examination of Water and Wastewater". The chlorine concentration of each step in the sterilization procedure shall be verified by chlorine residual determinations. This disinfecting solution shall be retained in the piping for at least twenty-four (24) hours, and all valves, hydrants, etc., shall be operated to disinfect all their parts. After this retention period, the water shall contain no less than the chlorine residual prescribed in AWWA C651 throughout the treated section of the pipeline.
3. This heavily chlorinated water shall then be carefully flushed from the line until the chlorine concentration is not higher than the residual generally prevailing in the existing distribution system, or approximately 1.0 parts per million. Proper planning and appropriate preparations to handle, dilute and dispose of this strong chlorine solution without causing injury or damage to the public, the water system, the environment must be approved by the City before flushing of the line may begin, and the flushing shall be witnessed by an authorized representative of the City.

H. Bacteriological Testing

1. After final flushing of the strong disinfecting solution, water samples from the line shall be tested for bacteriological quality, at the Contractor's expense, and must be found free of coliform organisms before the pipeline may be placed in service. One (1) test sample shall be drawn from the end of the main and additional samples collected at intervals of not more than one-thousand (1,000) feet along the pipeline. A minimum of three (3) samples must be collected.
2. The Contractor, at his own expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly shall be removed and retained for future use.
3. Samples for bacteriological analysis shall be collected only from suitable taps, in sterile bottles. Collection of the test samples shall be made in the presence of City personnel. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained, before the piping may be placed in service.

CIP12.07

FINAL ACCEPTANCE

- A. No pipe installation will be accepted until all known leaks have been repaired whether or not leakage is within allowable limits. Locating and repairing of leaks shall be performed by the Contractor at no additional cost to the City.
- B. The City will certify that all required pressure and leakage tests have been successfully completed before the pipeline is accepted.

CIP12.08

PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification,

and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP13 – SUMMARY OF TESTING (MISCELLANEOUS)

CIP13.01 SCOPE OF WORK

- A. This specification covers the requirements to perform testing of various work items for this Project.

CIP13.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature and all other pertinent data to illustrate conformance to the specification found within.

CIP13.03 TESTING FOR ROADS

- A. Testing for roads shall be in accordance with Table 13-1.

Table 13-1

Item	Test Method	Passing Criteria	Comments
Hot Mix Asphaltic Concrete (HMAC)	Tex-200-F	See SD1.06 A	Sieve Analysis of Fine and Coarse Aggregate Determining Density of Compacted Bituminous Mixtures Determining Asphalt Content of Bituminous Mixtures by Extraction Max. Specific Gravity of Bituminous Mixtures Stability
	Tex-207-F	94.5%-97.5%Lab Density; 91.0%-96.0%In-PlaceField Density	
	Tex-210-F	See SD 1.06 B	
	Tex-227-F		
	Tex-208-F	Max 35	
Trench Backfill	Applicable Tex Testing Method	See Section G4.05	Minimum of one test every 250 linear feet of trench length for each lift.
Embankment	Tex-114-E		Test every 2,000 SY of roadbed surface
Flexible Base	Tex-107-E, Part II Tex-411-A Tex-110-E	2% shrinkage	Bar Linear Shrinkage Magnesium Soundness Sieve Analysis Moisture Density Roadway Density Wet Ball Mill Triaxial Test (Part I or II) Particle Count (Part I) Plasticity Index Liquid Limit Moisture Content
	Tex-113-E	100% Density	
	Tex-115-E		
	Tex-116-E	40 Max.	
	Tex-117-E	45 psi @ 0 psi lateral & 175 psi @ 15 psi lateral	
		Max. increase ≤ 20	
	Tex-460-A	Plasticity Index ≤ 10	
	Tex-106-E	Liquid Limit ≤ 35	
	Tex-104-E	±2% Optimum	
	Tex-103-E		

Table 13-1 (continued)

Item	Test Method	Passing Criteria	Comments
Striping	Tex-828-B	10 or more stripes visible (day) 6 or more stripes visible (night) 0.060-inches minimum thickness for edgeline markings	Glass Beads: If criteria is not met, check Tex-828-B for scheduling replacement of striping.
	Tex-854-B	0.090-inches minimum thickness for stop bars, legends, symbols, gore and centerline/no passing barrier line markings 0.180-inches maximum thickness for all markings	The average of the readings across each sample must be equal to or above the specified minimum thickness. No reading should be more than 10-mils below the specified minimum thickness.

CIP13.04 TESTING FOR WATER/WASTEWATER

A. Testing for water/wastewater shall be in accordance with Table 13-2.

Table 13-2

Item	Test Method	Passing Criteria	Comments
Valves, Hydrants and Appurtenances	Manufacturer’s Recommendations	Manufacturer’s Recommendations	Functional field test of each valve, including actuators and valve control equipment.
Water and Wastewater Lines			As described in Section CIP12: Testing of Pipelines and Manholes

CIP13.05 TESTING FOR CONCRETE

A. Testing for concrete shall be in accordance with Table 13-3.

Table 13-3

Item	Test Method	Passing Criteria	Comments
Asphalt Board	Tex-524-C	Deflection from horizontal <1:3 ¹ / ₂	
Concrete Slump			See Table 13-4 for Slump
Coarse Aggregate	Tex-413-A Tex-410-A Tex-411-A	0.25% by weight clay lumps 1.00% by weight shale 5.00% by weight laminated and/or friable particles 40% wear 12% loss Sodium Sulfate 18% loss Magnesium Sulfate	See Table 13-5 for Gradation Soundness Test

Table 13-3 (continued)

Item	Test Method	Passing Criteria	Comments
Fine Aggregate	Tex-612-J	60% by weight acid insoluble residue subject to direct traffic. Color shall not be darker than Organic Color No. 3 (Gardner No. 11)	Color Test
	Tex-408-A		
	Tex-401-F	Not less than 80 Between 2.3 & 3.1 for Non-Class K Between 2.6 & 2.8 for Class K	See Table 13-6 for Gradation Sand Equivalent Fineness Modulus
	Tex-203-F Tex-402-A		
Membrane Curing	Tex-219-F	2% loss for 24-hour test 4% loss for 72-hour test	Water Retention Test

Table 13-4

Concrete Designation	Slump	Maximum Slump
1. All drill shaft	6	7
2. Uncased drill shafts, thin walled sections (<9") and pre-stressed concrete members	4	5
3. Slabs, caps, columns, piers, wall sections over 9", etc.	3	4
4. Underwater or seal concrete	6	7
5. Riprap, curb, gutter and other miscellaneous concrete.	As specified by City.	

Table 13-5

Aggregate Grade No.	Nominal Size (in)	Amount Retained (%)								
		2 1/2 in	2 in	1 1/2 in	1 in	3/4 in	1/2 in	3/8 in	No 4	No 8
1	2	0	0-20	15-50		60-80			95-100	
2 (467)*	1 1/2			0-5		30-65		70-90	95-100	
3	1 1/2			0-5		10-40	40-75		95-100	
4 (57)*	1				0-5		40-75		90-100	95-100
5 (67)*	1/4					0-10		45-80	90-100	95-100
6 (7)*	1/2							30-60	85-100	95-100
7	3/8							5-30	75-100	
8	3/8							0-5	35-80	90-100

Table 13-6

Aggregate Grade No.	Amount Retained (%)							
	3/8 in	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1	0	0-5	0-20	15-50	35-75	65-90	90-100	97-100

CIP13.06

PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION CIP14 – PROJECT CLOSEOUT

CIP14.01

SCOPE OF WORK

- A. This specification covers the administrative and procedural requirements for Project closeout, including but not limited to:
1. Closeout procedures.
 2. Final cleaning.
 3. Adjusting.
 4. Project record documents.
 5. Spare parts and maintenance materials.

CIP14.02

RECORD DOCUMENTS

- A. Maintain on site, one set of the following documents; actual revisions to the Work shall be recorded in these documents:
1. Contract Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other Modifications to the Contract.
 5. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and Modifications.
- E. Contract Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
1. Measured depths of foundations in relation to finish floor datum.
 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

4. Field changes of dimension and detail.
 5. Details not on original Contract Drawings.
- F. Submit documents to City with claim for final Application or Payment. Retention monies will not be released until complete record documents have been submitted.

CIP14.03

CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's and/or City's inspection.
- B. Provide submittals to the City that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

CIP14.04

FINAL CLEANING

- A. At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:
 1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the City.
 2. All Subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.
 3. The Contractor shall remove all temporary structures and all debris including all dirt, sand, gravel, rubbish and waste material.
 4. Should the Contractor not remove rubbish or debris, or not clean the buildings and site as specified above, the City reserves the right to have the cleaning done at the expense of the Contractor.
- B. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.
- D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces and of concealed spaces.
- E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
- F. Repair, patch, and touch up marred surfaces to specified finish to match adjacent surfaces.
- G. Replace air-handling filters if units were operated during construction.
- H. Vacuum clean all interior spaces, including inside cabinets. Broom clean paved surfaces, mow

any areas planted with grass which are in excess of two (2) inches high, and rake clean other surfaces of grounds.

- I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.
- J. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

CIP14.05

ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

CIP14.06

FINAL INSPECTION

- A. After final cleaning and restoration and upon written notice from the Contractor that the work is completed, the Engineer and/or City will make a preliminary inspection with the Contractor present. Upon completion of this preliminary inspection, the Engineer and/or City will notify the Contractor, in writing, of any particulars in which this inspection reveals that the work is defective or incomplete.
- B. Upon receiving written notice from the Engineer and/or City, the Contractor shall immediately undertake the work required to remedy deficiencies and complete the work to the satisfaction of the City.
- C. When the Contractor has corrected or completed the items as listed in the Engineer's/City's written notice, he/she shall inform the City in writing that the required work has been completed. Upon receipt of this notice, the Engineer and/or City and the Contractor, will make the final inspection of the Project.
- D. Should the Engineer and/or City find all work satisfactory at the time of his inspection, the Contractor will be allowed to make application for final payment in accordance with the provisions of the Standard Form of Agreement. Should the Engineer and/or City still find deficiencies in the work, the Engineer and/or City will inform the Contractor of the deficiencies and will deny the Contractor's request for final payment until such time as the Contractor has satisfactorily completed the required work. Additional inspections of deficiencies shall be paid for by the Contractor at \$200.00 per inspection.

CIP14.07

ACCESSORY ITEMS

- A. The Contractor shall provide to the City, upon acceptance of the equipment, all special accessories required to place each item of equipment in full operation. These special accessory items include, but are not limited to, the specified spare parts, adequate oil and grease as required for the first lubrication of the equipment, initial fill-up of all chemical tanks and fuel tanks, light bulbs, fuses, hydrant wrenches, valve wrenches, valve keys, handwheels, and other expendable items as required for initial start-up and operation of all equipment.

CIP14.08

GUARANTEES, BONDS, AND AFFIDAVITS

- A. No application for final payment will be accepted until all guarantees, bonds, certificates, licenses, and affidavits required for work or equipment as specified are satisfactorily filed with the Engineer.

CIP14.09

RELEASE OF LIENS OR CLAIMS

- A. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the City as required by the Standard Form of Agreement.

CIP14.10

FINAL PAYMENT

- A. Final payment will be made to the Contractor in accordance with Item 47 - “Payment Procedures”, Standard Form of Agreement. Final payment and release of retention monies will not be made until the Contractor has submitted one set of as-built plans to the City for the Project.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP15 – PROJECT IDENTIFICATION SIGNAGE

CIP15.01

SCOPE OF WORK

- A. This specification covers the requirements for furnishing, fabricating and erecting Project Signs on Capital Improvement Projects (CIPs) and for project identification at other construction sites when required on the Plans or by the City.

CIP15.02

MATERIALS

- A. Sign Face: The sign face shall be manufactured on standard exterior waterproof plywood sheets or other suitable material approved by the Engineer or the City. Unless indicated otherwise on the Plans, the thickness of the plywood sheet shall be a minimum of ³/₄-inches.
- B. Posts: Plastic post, of the size indicated on the Plans, shall be pressure treated with pentachlorophenol.
- C. Paint: Exterior oil base paint shall be used and colors shall be as indicated on the Plans.
- D. Signs for Capital Improvements Projects: City seals shall be provided by the City.

CIP15.03

INSTALLATION

- A. The signs shall be erected at each major entrance to the project for maximum public identification and exposure. At locations where construction is confined to an adequate area defined by the City, the installed sign size shall be four feet by eight feet (4' x 8'). At locations where roadway construction is in progress, such as a street paving or construction of a sidewalk, the sign shall be two feet by three feet (2' x 3'). The signs shall be posted on portable wood frames or stanchions and will be located in the proximity of the work area as construction progresses. All lumber shall be painted with two (2) coats of paint as indicated on the Plans.
- B. In special cases, the size of the sign may be changed to meet special requirements but general proportions shall be maintained.
- C. It shall be the responsibility of the Contractor to maintain and relocate signs, if necessary, during the progression of the project. Care shall be exercised to assure that placement of the signs does not interfere with or cause sight obstruction to vehicular and pedestrian traffic.
- D. The Contractor may install, at his own expense, company signs to identify the Contractor, Developer, etc. Signs are to be securely attached to the posts at locations indicated on the Plans and shall not be larger than 18-inches by 36-inches.

CIP15.04

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION CIP16 – WARRANTY

CIP16.01

SCOPE OF WORK

- A. This specification covers the requirements of the Contractor's or Developer's two (2) year warranty period for all work performed on the Project.
- B. Individual specification sections may require warranty periods greater than one year on certain pieces of equipment or construction. When so specified, the longer warranty periods as specified will take precedent over the one year warranty specified below.

CIP16.02

WARRANTY

- A. Upon final acceptance by the City of Georgetown, the Contractor warrants for a period of two (2) years, the construction of the Project according to Plans and Specifications as they may be modified in accordance with the Contract Documents, and further warrants the proper operation of mechanical, electrical, and other devices or other equipment, if any, included in the project for a period of two (2) years. The Contractor or Developer warrants to the City that all materials and equipment furnished under this Contract shall be new unless otherwise approved by the City's Representative and that all work will be of good quality, free from faults and defects, and in conformance to these requirements, including substitutions not properly approved and authorized, may be considered defective.
- B. This warranty is in addition to any rights or warranties expressed or implied by law and consumer protection claims arising from misrepresentations by the Contractor or Developer. This warranty obligation shall be covered by any performance or payment bonds tendered in compliance with the Contract Provisions.
- C. If within two (2) years after the date of substantial completion of the work or designated portion thereof, or within two (2) years after acceptance by the City of the designated Project, or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents, any of the work is found or determined to be defective, including obvious defects, or otherwise not in accordance with the Contract Documents, the Contractor or Developer shall correct it promptly.
- D. If within 10 days after the City has notified the Contractor or Developer of a defect, failure, or abnormality in the work, the Contractor or Developer has not started to make the necessary repairs or adjustments, the City is hereby authorized to make the repairs or adjustments, or to order the work to be done by a third party. The cost of the work shall be paid by the Contractor or Developer. The cost of all materials, parts labor, transportation, supervision, special tools, and supplies required for the replacement or repair of parts and for correction of defects, shall be paid by the Contractor, Developer or by the surety. This guarantee shall be extended to cover all repairs and replacements furnished under the guarantee, and the period of the guarantee for each repair or replacement shall be two (2) years after the installation or completion. The two (2) year warranty shall cover all work equipment, and materials that are part of this project, whether or not a warranty is specified in the individual section prescribing that particular aspect of the work. Where more than a two (2) year warranty is specified in the individual section, that warranty shall govern.

- E. After receipt of written notice from the City to begin corrective work, the Contractor or Developer shall promptly begin the corrective work, unless the City's Representative has previously given the Contractor a written acceptance of such condition. This obligation shall survive the termination of the Contract. This guarantee shall not constitute the exclusive remedy of the City, nor shall other remedies be limited to either the warranty or guarantee period.

CIP16.03

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP17 – INSPECTION OF PROJECTS

CIP17.01

INSPECTION

- A. All Projects, whether by a private development or the City of Georgetown, shall be inspected by the City or a designated representative of the City.
- B. The time that the City of Georgetown or its designated representative will be available for inspection is from 8:00 a.m. to 12:00 p.m. and 1:00 p.m. to 5:00 p.m. on working days. Working days shall be defined as Monday through Saturday (excluding all holidays observed by the City of Georgetown). All inspections shall be scheduled with the City a minimum of two (2) working days prior to the inspection.
- C. If the Contractor, for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request to the City and he shall allow ample time for satisfactory arrangements to be made for inspecting the Work in progress. The Contractor shall pay the expenses for extra inspection required for work outside regular hours at a rate of \$50.00/hour. Normal working hours for this purpose are Monday through Saturday, 7:00 a.m. to 6:00 p.m. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Georgetown.

CIP17.02

AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the Work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the Work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the Work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these Specifications, nor to approve or accept any portion of the Work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the Work.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION G2 – SITE PREPARATION

G2.01 SCOPE OF WORK

- A. This specification covers the requirements for performing all clearing, grubbing and stripping of topsoil complete as shown on the Plans and as specified herein.

G2.02 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards or requested by the City or the Engineer.

G2.03 CLEARING AND GRUBBING

- A. Except as otherwise directed, cut, grub, remove and dispose of all trees, stumps, brush, shrubs, roots and any other objectionable material within the limits defined on the Plans.
- B. All trees, stumps, brush, shrubs, roots and other objectionable material shall be cut, grubbed, removed and disposed of from areas to be occupied by buildings, structures, roads, pipelines and any other areas to be stripped. Trees and brush shall be removed to a depth at least three (3) feet below the finished grade.
- C. In addition, heavy growths of weeds or other plants shall be stripped from the surface in order to provide clear access to the work site and to prevent their inclusion in stockpiled soil which is to be reused later. Trees, stumps, surface plants and all debris removed from the site shall be disposed of off-site by the Contractor at his own expense.
- D. Before the start of construction, protect trees or groups of trees, designated by the Engineer to remain, from damage by all construction operations by erecting suitable barriers, or by other approved means. Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees designated to remain.
- E. Areas outside the limits of clearing shall be protected from damage and no equipment or materials shall be stored in these areas.
- F. No stumps, trees, limbs, or brush shall be buried in any fills or embankments.

G2.04 STRIPPING

- A. Strip topsoil from all areas to be occupied by buildings, structures, roadways and all areas to be excavated or filled. Avoid mixing topsoil with subsoil and stockpile topsoil in areas on the site as approved by the Engineer. Topsoil shall be free from brush, trash, large stones and other extraneous material and protected until it is placed as specified under Section G7-LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL. Dispose of any remaining topsoil as directed by the City. All excess topsoil shall remain property of the City at its option, and Contractor shall place extra materials at a site designated by the City.

G2.05

DISPOSAL OF MATERIALS

- A. All tree trunks, limbs, roots, stumps, brush, foliage, other vegetation and objectionable material shall be removed from the site and disposed of in a permitted disposal site in a manner satisfactory to the Engineer.
- B. Burning of cleared and grubbed materials will not be permitted.
- C. Disposal of Excavated Materials
 - 1. Suitable excavated materials may be stockpiled to be used for backfilling. Excess excavated materials and unsuitable backfill materials shall be disposed of by the Contractor in the following manner:
 - a. Clays, sands and gravel in excess of project requirements shall be disposed of by the Contractor at such locations and under consideration arranged by the Contractor at his expense.
 - b. Limestone and other rock excavation shall be disposed of by the Contractor at such locations and under consideration arranged by the Contractor at his expense.
 - 2. The classification of clays, sands, gravel, limestone and rock shall be made in accordance with the Unified Soil Classification System, U.S. Army Corps of Engineers, T.M. 3-357.
 - 3. Desirable topsoil, sod, or area fill shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to the City's operations, and to permit safe and convenient access to private and public property adjacent to the work

G2.06

UNAUTHORIZED EXCAVATION

- A. Whenever the excavation is carried beyond or below the lines and grades as shown on the plans, except as specified above, all such excavated space shall be refilled with such material and in such a manner, as may be directed by the City, so as to insure the stability of the affected structure. Beneath all structures, space excavated without authority shall be refilled by the Contractor, at his own expense, with Class "C" concrete, crushed stone or selected fill materials, as directed by the City.

G2.07

PAYMENT

- A. Payment will be made for work performed in accordance with this specification by the unit quantity for the item for right-of-way preparation in the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION G3 – SITE CLEARING

G3.01 SCOPE OF WORK

- A. This specification covers the requirements for site clearing operations for this Project.

G3.02 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards, or requested by the City or the Engineer.

G3.03 TRAFFIC

- A. Conduct site-clearing operations to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

G3.04 PROTECTION

- A. Provide temporary fences, barricades, coverings, or other protection to preserve existing items indicated to remain and to prevent injury or damage to persons or property. Provide protection for adjacent properties as required.
- B. Restore damaged work to condition existing prior to start of work.
- C. Protect existing trees and vegetation that are indicated to remain from physical damage. Do not store materials or equipment within tree drip line. Replace damaged trees that cannot be restored to full growth, as determined by arborist, unless otherwise acceptable to the Engineer or the City.
- D. Protect existing property and easement corners and pins. In the event that property or easement corners or pins are moved, disturbed or destroyed, the Contractor shall replace them at his own expense. They shall be replaced by a Registered Professional Land Surveyor registered in the State of Texas.

G3.05 EXISTING SERVICES

- A. Locations indicated are approximate; determine exact location before commencing work. Coordinate with local utility service requirements and comply with their instructions.

G3.06 SITE CLEARING

- A. Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as indicated or that interfere with new construction. Removal includes digging out stumps and roots, together with subsequent off-site disposal.
- B. Strip and stockpile topsoil that will be reused in the Work.
- C. Remove existing improvements, both above-grade and below-grade, to extent indicated or as otherwise required to permit new construction.

G3.07

SALVAGEABLE ITEMS

- A. Carefully remove items indicated to be salvaged and store on the City's premises where indicated or directed.

G3.08

AIR POLLUTION

- A. Control air pollution caused by dust and dirt; comply with governing regulations.

G3.09

REGRADING

- A. Fill depressions and voids resulting from site-clearing operations. Using satisfactory soil materials, place in maximum six (6) inch deep horizontal layers and compact each layer to density of surrounding original ground.
- B. Grade ground surface to conform to required contours and to provide surface drainage.

G3.10

DISPOSAL OF MATERIAL

- A. Dispose of waste materials including trash, debris and excess topsoil. No waste material shall remain on the City's property.
- B. Burning waste materials on site is not permitted.

G3.11

PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION G4 - PIPE EXCAVATION, TRENCHING, EMBEDMENT,
ENCASEMENT AND BACKFILLING

G4.01 SCOPE OF WORK

- A. This specification covers the requirements for furnishing all labor, equipment and material and performing all work necessary, in connection with excavation, trenching, embedment, encasement, and backfilling, for the installation of wastewater lines in this Project.

G4.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including a Trench Safety Plan (which shall be sealed by a Professional Engineer registered in the State of Texas, if required) embedment material (source, gradation and type), backfill material (source, gradation and type), encasement material (if required), equipment and all other pertinent data to illustrate conformance to the specification found within.

G4.03 EXCAVATION

A. General

1. Excavation shall include the removal of any trees, stumps, brush, debris, or other obstacles that may obstruct the line of work, and the excavation and removal of all earth, rock or other materials to the extent necessary to install the pipe and appurtenances in conformance with the line and grades shown in the Plans, or as specified.

B. Maximum and Minimum Width of Trenches

1. The sides of all trenches shall be cut as nearly vertical as possible. Unless otherwise specified on the Plans, the minimum width of trench in which the pipe may be installed shall not be less than 12-inches plus the outside diameter of the pipe, and the maximum width shall not be more than 24-inches plus the outside diameter of the pipe, measured at an elevation in the trench which is 12-inches above the top of the pipe when it is laid to grade.
2. Wherever the prescribed maximum trench width is exceeded, the Contractor shall use the class embedment or encasement required by the Engineer to provide the load carrying capacity for the trench width as actually cut, and the additional cost incurred will be borne by the Contractor.

C. Sheeting and Shoring

1. Where required in the Contractor's Trench Safety System, or where required for other reasons in caving ground, or in wet, saturated or flowing materials, the sides of all trenches and excavations shall be adequately sheeted and braced so as to maintain the excavation free from slides or cave-ins.
2. Shoring and sheeting shall not be left in place unless its removal is impractical.

D. Dewatering Excavations

1. There shall be sufficient pumping equipment, in good working order, available at all times to remove any water that accumulates in excavations. Where the pipeline crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the work will be prevented. Provisions shall be made for the satisfactory disposal of surface water pumped so as to prevent damage to public or private property. The Contractor shall be responsible for maintaining safe working conditions and suitable construction techniques.

E. Disposal of Excavated Materials

1. Suitable excavated materials may be piled adjacent to the work to be used for backfilling. Excavated materials unsuitable for backfilling, or in excess of that required for backfilling, shall be disposed of by the Contractor. Desirable topsoil, sod, etc. shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to public travel. Suitable selected bedding or backfill material shall be provided at no additional cost to the City.

F. Trench Depth

1. Excavation for the pipeline shall be removed to a depth below the pipe barrel and pipe bell as shown in the Plans for the type of embedment specified, and the bottom of the trench brought to true subgrade with the embedment or encasement shown in the Plans.

G. Soft Subgrade

1. Where soft or spongy material is encountered in the excavation at subgrade level, it shall be removed to such a depth that a stable foundation is achieved by replacing the unsuitable material with tamped gravel, brought to the level of the bottom of bedding.
2. Gravel used shall be washed gravel or crushed stone and may fit any gradation of size up to three (3) inches. The particular gradation shall take into consideration the actual field conditions.

H. Excavated Materials

1. Excavated materials shall be piled adjacent to the work to be used for backfilling as required. After the trench has been refilled, topsoil shall be replaced to the extent that rock excavated from the trench will be completely covered and the area is returned to its original condition.
2. Where required on the Plans or when otherwise specified, desirable topsoil shall be piled separately in a careful manner and replaced in its original position.
3. Where a trench is required to cross a paved area, the asphalt or concrete shall be saw cut and removed for a total width that is two (2) feet greater than the trench width. The Contractor shall dispose of all excavated concrete, asphalt and subgrade material that is unsuitable for backfilling or in excess of that required for backfilling.

I. Damage to Existing Utilities

1. Where existing utilities are damaged, they shall be replaced immediately with material equal to or better than the existing material. Such work shall be at the entire expense of the Contractor.

G4.04

EMBEDMENT AND ENCASEMENT

A. General

1. Embedment shall be as required in the Plans or Standards. All embedment materials shall be free of grass, roots, vegetation, and other deleterious materials. Embedment Standards are shown on the Plans or Standards.
2. When the pipe has been checked for line and grade, the trench shall be backfilled with enough granular material or concrete on both sides to hold the pipe firmly in position. When placing granular material or concrete around the pipe, care shall be taken to fill all voids around the pipe. The pipe shall not be floated. The embedment or encasement material shall be carefully tamped to assure uniform pipe support and density.

B. Embedment Materials

1. Material for embedment shall conform to the following sieve analysis:

<u>Sieve Size</u>	<u>^{3/8"} F % Retained</u>	<u>^{1/2"} D % Retained</u>
1/2"	0	0
3/8"	0-2	5-25
4m	40-85	80-100
10m	95-100	96-100

C. Concrete Embedment and Encasement

1. Concrete embedment and encasement and cap shall have a minimum compressive strength of 2,000 pounds per square inch at 28 days.
2. Dry mix will not be permitted. The concrete cushion portion of the embedment or encasement will be mixed moist or damp to give a slump of not more than one inch. Concrete for the sides and top, if specified, shall be mixed to obtain a slump of not less than one inch or more than three (3) inches.
3. After pipe joints are completed, the voids at the joints in the embedment section shall be filled with concrete, and the embedment shall be brought up to proper grade. Where concrete is placed over or along the pipe, it shall be placed in such a manner as not to damage or injure the joints or displace the pipe. Care shall be taken in the placement of concrete to assure that a uniform pad, free of voids and of specified thickness, is constructed under the entire pipe section.
4. A cleavage line between the base concrete and the side embedment concrete will not be allowed. Backfilling shall be done in a careful manner and at such time, after concrete embedment or encasement has been placed, as not to damage the concrete in any way.

G4.05

BACKFILLING

A. General

1. Backfilling shall include the refilling and consolidating of the fill in trenches and excavations up to the surrounding ground surface or road grade at crossings. No backfill shall be placed until the Engineer, the City or his authorized Inspector has inspected the trench and pipe in place and has authorized the placing of backfill.
2. Backfilling shall be done with select material or concrete backfill as described hereafter and shown on the Plans. No material of a perishable, spongy or otherwise unsuitable nature shall be used in backfilling.

B. Select Backfill Material

1. Unless otherwise shown on the Plans, or approved by the Engineer, the select material backfill shall be Specification Section SD4 Flexible Base, Type A Grade 1.
2. If approved by the Engineer, good, sound earth may be used as select material for backfill over the pipe. Good, sound earth as defined as gravel, sandy loam or loam, free from excessive clay. Select material shall not have rocks with an average dimension larger than one inch, and no dimension greater than two (2) inches.
3. An alternative to the flexible base as select backfill will be on-site or imported select material so long as it is properly moisture-conditioned, placed and compacted.
4. It shall be the full responsibility of the Contractor to explore the project and subsurface materials to determine if the trench excavation will be suitable for use as select materials and to follow as closely as possible this Specification to insure a good, sound pipeline when completed.

C. Concrete Trench Cap

1. Where 36-inch minimum cover cannot be obtained or due to potential surface loading, the City may require a cap to be installed.

D. Concrete Backfill

1. Where shown on the Plans, concrete backfill shall consist of selected rock material or granular sand material mixed with a minimum of three sacks of cement per cubic yard. All material shall be mixed in a concrete mixer or transit mixed unless otherwise approved by the City.

E. Backfilling Operation

1. Backfilling operation outside of pavement shall be compacted to the required density without damaging the pipe or bedding. Backfill under non paved areas, two (2) feet outside of any structure or utilities and excluding lines within a floodplain, streams and watercourses shall be compacted to 90% of the maximum dry density in accordance Tex-114-E. Areas within two (2) feet of structures or existing utilities and areas within a floodplain, streams and water courses shall be compacted to 95% in accordance with Tex-114-E. Prior to any compaction, moisture shall be within +3% of the optimum moisture content.
2. All trenches under proposed or existing concrete roadways, driveways and sidewalks, paved waterways, brick roadways, asphaltic roadways with concrete base, gravel

roadways, and roadways with gravel base and asphalt surface, shall be backfilled to the required density in six (6) inch maximum lifts without damaging the pipe or bedding except the first lift over the pipe bedding will be 12 inches in depth. Swelling soils (soils with a plasticity index of 20 or more) shall be sprinkled as required to provide not less than optimum moisture nor more than 3% over the optimum moisture content to the extent necessary to provide not less than 95% nor more than 102% of the maximum dry density as determined in accordance with Tex-114-E. Non-swelling soils (soils with a plasticity index less than 20) shall be sprinkled as required and compacted to the extent necessary to provide not less than 95% of the optimum dry density with the moisture within +3% of the optimum moisture content in accordance with Tex-114-E. Jetting with water will not be permitted. Flexible base used as select backfill shall be compacted to 95% of Tex-113E at +3% of the optimum moisture content.

3. After the trench has been refilled, topsoil shall be replaced to the extent that rock excavated from the trench will be completely covered or removed and the area is returned to its original condition, except that in cultivated areas a minimum of six (6) inches of topsoil shall be replaced.

G4.06

PAYMENT

- A. For all piping, there shall be no separate payment made for work performed under this Specification for excavating, trenching, embedment, and backfilling. All costs incurred shall be included in the contract price for the appropriate items in the Proposal and Bid Schedule.
- B. Separate payment, if authorized by the City, will be made for crushed stone or washed gravel as described in these specifications under Section G4.02(G), SOFT SUBGRADE, at the contract unit price per cubic yard as provided in the Proposal and Bid Schedule (if applicable).

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION G5 – GRANULAR FILL MATERIALS

G5.01 SCOPE OF WORK

A. This specification covers the requirements for the use of granular fill materials for this Project.

G5.02 SUBMITTALS

A. Within 30 days after the Notice to Proceed, the Contractor shall submit to Engineer or the City for approval, technical product literature including the source of the material, gradation, type of material, and all other pertinent data to illustrate conformance to the specification found within.

G5.03 GENERAL

A. Granular fill materials are specified in this Section, but their use for bedding pipe, pavement base, are specified in detail in sections G4 – PIPE EXCAVATION, TRENCHING, EMBEDMENT, ENCASEMENT AND BACKFILLING and SD4 – FLEXIBLE BASE. The Engineer may respectively order the use of fill materials for purposes other than those specified in other Sections if, in his/her opinion, such use is advisable.

G5.04 MATERIALS

A. Common fill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible, or which cannot be compacted properly. Common fill shall not contain stones larger than six (6) inches in any dimension, broken concrete, masonry, rubble, asphalt pavement, or other similar materials. It shall have physical properties, as approved by the Engineer, such that it can be readily spread and compacted.

B. Select common fill shall be as specified above for common fill except that the material shall contain no stones larger than two (2) inches in its largest dimension.

C. Crushed Stone Backfill shall consist of hard, durable, particles of proper size and gradation, free from sand, loam, clay, excess fines and deleterious materials. The size of the particles shall be uniformly graded such that the following bedding specifications are met:

<u>Sieve Size</u>	<u>3/8" F % Retained</u>	<u>1/2" D % Retained</u>	<u>Washed Gravel % Retained</u>
1/2"	0	0	0
3/8"	0-2	5-25	---
4m	40-85	80-100	---
10m	95-100	96-100	---
3/4"	---	---	100

D. Crushed Stone Base shall consist of sound, durable stone, free of any foreign material, angular in shape, free from structural defects and comparatively free of chemical decay. This material shall comply with Texas Department of Transportation Item 248, Type "A", Grade 1 unless otherwise shown on the Plans or Standards. The stone shall have a maximum size of 7/8-inch.

- E. Cement Stabilization Sand Backfill shall consist of a mixture of ASTM C33 fine aggregate and Type I cement. The mix shall be proportioned of two (2) sacks of cement per cubic yard.

G5.05

PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION G6 – SEDIMENTATION AND TEMPORARY EROSION CONTROL

G6.01 SCOPE OF WORK

- A. This specification covers the requirements necessary to perform all installation, maintenance, removal and area cleanup related to sedimentation control work as shown on the Plans and as specified herein.

G6.02 SUBMITTALS

- A. Within 10 days after Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature for all commercial products to be used for sedimentation and erosion control.

G6.03 GENERAL

- A. The work shall include, but not necessarily be limited to: triangular filter dike, rock berm, silt fence, curb inlet protection, stabilized construction entrance, tree protection, excelsior matting, and temporary mulching, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, excelsior matting installation and final cleanup. All sedimentation and erosion control shall be installed prior to the start of any construction activities.

G6.04 QUALITY ASSURANCE

- A. The Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Plans necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the City will be considered.
- B. Sedimentation and erosion control measures shall conform to the requirements outlined in the Texas Commission on Environmental Quality (TCEQ) Chapter 213.

G6.05 MATERIALS

- A. Triangular Filter Dike
1. Triangular filter dike sections shall be either 10-feet or 20-feet in length.
 2. Geotextile fabric shall extend to 12-inches upstream of triangular filter dike structure.
 3. Triangular filter dike structure shall be 18-inches in length on all three (3) faces.
 4. Three (3) inch to five (5) inch open graded rock shall be placed over skirt to anchor it on the upstream side.
 5. Structure shall be formed by six (6) gauge six inch by six inch (6" x 6") welded wire mesh.

6. Geotextile fabric shall be non-woven, 4.5 oz. minimum and 36-inches wide.
- B. Rock Berm
1. Woven wire sheathing shall be 20-gauge with one inch openings.
 2. Rock shall be three inches to five inches (3" - 5") open graded.
- C. Silt Fence
1. Steel posts shall be a minimum of four (4) feet in length, heavy weight T-Post.
 2. Welded wire fabric shall be two-inch by four-inch (2" x 4") mesh of 12-gauge by 12-gauge galvanized wire mesh.
 3. Silt fence fabric shall be a 4.5 oz minimum non-woven geotextile filter fabric 36-inches wide.
 4. Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings), or $\frac{1}{32}$ -inch diameter soft aluminum wire.
 5. Prefabricated commercial silt fence may be substituted for built-in-field fence. Prefabricated silt fence shall be "Envirofence" as manufactured by Mirafi Inc., Charlotte, NC or equal.
- D. Curb Inlet Protection
1. 4.5 oz. minimum non-woven geotextile filter fabric shall be used.
 2. Sand bags shall be used to hold the filter fabric in place.
- E. Stabilized Construction Entrance
1. Stabilized construction entrance shall have a minimum width of 12-feet and a minimum length of 50-feet.
 2. An eight (8) inch high diversion ridge shall be constructed 15-feet from the edge of the existing roadway.
 3. Stabilized construction entrance shall be graded to drain towards the existing roadway at a two-percent (2%) slope.
 4. Rock shall be four-inches to eight-inches (4" - 8") coarse aggregate.
 5. Rock shall be placed to a depth of at least eight (8) inches.
- F. Tree Protection – Chain Link Fence
1. Chain link fence shall be five (5) feet in height.
 2. Fence shall be installed around the driplines of the trees to be protected.
- G. Tree Protection – Wood Slats

1. Where any exceptions result in a fence being closer than four (4) feet to a tree trunk, protect the trunk with strapped-on-planking two inches by four inches (2" x 4") wood slats to a height of eight (8) feet, or to the limits of lower branching in addition to the reduced fencing provided.
2. Trees most heavily impacted by construction activities should be watered deeply once a week during periods of hot, dry weather. Tree crowns should be sprayed with water periodically to reduce dust accumulation on the leaves.
3. Any trenching required for the installation of landscape irrigation shall be placed as far from existing tree trunks as possible.
4. No landscape topsoil dressing greater than four (4) inches shall be permitted within the dripline of a tree. No soil is permitted on the root flare of any tree.
5. No vehicles or equipment shall be allowed to park within the dripline of an existing tree.

H. Soil Retention Blankets

1. Soil retention blankets shall be installed in all seeded drainage swales and ditches as shown on the Plans or as directed by the Engineer. Only soil retention blankets included on TxDOT's Approved Products List will be considered acceptable for use on this Project.
2. Contractor is to include this item in their erosion controls as required by the City and by the Contractor's Stormwater Pollution Prevention Plan (SWPPP). The Blankets must meet the expected velocities in the area to prevent erosion of the soil of the post-constructed area. Contractor is to submit the proposed material prior to construction for Engineer's and City's approval.

I. Temporary Mulch

1. Temporary mulch shall be applied to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.

G6.06

INSTALLATION

A. Triangular Filter Dike

1. Layout the filter dike following as closely as possible to the contour.
2. Clear the ground of debris, rocks, and plants that will interfere with installation.
3. Place the filter dike sections one at a time, with the skirt on the uphill side towards the direction of flow anchoring each section to the ground before the next section is placed.
4. Anchors should be placed on two (2) foot centers alternating from front to back so that there is actually only one foot in between anchors.
5. Securely fasten the skirt from one section of filter dike to the next.

6. Filter dikes must maintain continuous contact with the ground.
7. After the site is completely stabilized, the dikes and any remaining silt should be removed. Silt should be disposed of in a manner that will not contribute to additional siltation.

B. Rock Berm Installation

1. Layout the rock berm following as closely as possible to the contour.
2. Clear the ground of debris, rocks or plants that will interfere with installation.
3. Place woven wire fabric on the ground along the proposed installation with enough overlap to completely encircle the finished size of the berm.
4. Place the rock along the center of the wire to the designated height.
5. Wrap the structure with the previously placed wire mesh secure enough so that when walked across, the structure retains its shape.
6. Secure with tie wire.
7. The ends of the berm should be tied into existing upslope grade and the berm should be buried in a trench approximately four (4) inches deep to prevent failure of the control.
8. The rock berm should be left in place until all upstream areas are stabilized and accumulated silt removed.

C. Silt Fence Installation

1. Lay out the silt fence following as closely as possible to the contour.
2. Clear the ground of debris, rocks, and plants (including grasses taller than two (2) inches) to provide a smooth flow approach surface. Excavate four-inches deep by four-inches wide (4" x 4") trench on upstream side of face per Plans.
3. Drive the heavy duty T-post at least 12-inches into the ground and at a slight angle towards the flow.
4. Attach the two-inches by four-inches (2" x 4") 12-gauge welded wire mesh to the T-post with 1 1/2-gauge galvanized T-post clips. The top of the wire shall be 24-inches above ground level. The welded wire mesh shall be overlapped six (6) inches and tied at least six (6) times with hog rings.
5. The silt fence shall be installed with a skirt a minimum of 11-inches wide placed on the uphill side of the fence inside excavated trench. The fabric to overlap the top of the wire by one inch.
6. Anchor the silt fence by backfilling with excavated dirt and rocks.
7. Geotextile splices should be a minimum of 18-inches wide attached in at least six (6) places.

D. Curb Inlet Protection Installation

1. Clear the pavement of debris, rocks, etc. to provide a smooth surface for installation.
2. Place the filter fabric over the inlet and extend to five (5) feet beyond inlet opening, upstream of inlet. Terminate fabric in street gutter with sand bags placed in gutter flowline.
3. Place sandbags on top of filter fabric around the perimeter of the protected area to secure the filter fabric.
4. Care shall be taken insure that the inlet protection will remain in place during periods of heavy runoff and that severe ponding will not occur in the street.

E. Stabilized Construction Entrance Installation

1. Clear the area of debris, rocks or plants that will interfere with installation.
2. Grade the area for the entrance to flow back on to the construction site. Runoff from the stabilized construction entrance onto a public street will not be allowed except for the first 15 feet connecting to the public street.
3. Place geotextile fabric (if required).
4. Place rock (as required).

F. Tree Protection – Chain Link Fence

1. Tree protection fences shall be installed prior to the commencement of any site preparation work (i.e., clearing, grubbing or grading).
2. Fences shall completely surround the tree, or clusters of trees; will be located at the outermost limit of the tree branches (dripline); and will be maintained throughout the construction project in order to prevent the following:
 - a. Soil compaction in the root zone area resulting from vehicular traffic, or storage of equipment or materials.
 - b. Root zone disturbances due to grade changes greater than six (6) inches, cut or fill, or trenching not reviewed and authorized by the City.
 - c. Wounds to exposed roots, trunks or limbs by mechanical equipment.
 - d. Other activities detrimental to trees such as chemical storage, cement truck cleaning and fire.
3. Exceptions to installing fences at tree driplines may be permitted in the following cases:
 - a. Where permeable paving is to be installed, erect the fence at the outer limits of the permeable paving area.
 - b. Where trees are close to a proposed building, erect the fence no closer than six (6) feet to building.

G. Tree Protection – Wood Slats

1. Any roots exposed by construction activity shall be pruned flush with the soil. Backfill root areas with good quality top soil as soon as possible. If exposed root areas are not backfilled within two (2) days, cover them with organic material in a manner which reduces soil temperature, and minimizes water loss due to evaporation.
2. Prior to excavation or grade cutting within tree dripline, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment, to minimize damage to remaining roots.
3. Pruning to provide clearance for structures, vehicular traffic and equipment shall take place before construction starts.

H. Excelsior Matting

1. The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied.
2. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area.
3. The blankets shall be applied in the direction of water flow, and stapled. Blankets shall be placed a minimum of three (3) rows, of four (4) foot wide (total approximate 12-foot width) within the drainage swale/ditch and stapled together in accordance with Manufacturer's instructions.
4. Side overlaps shall be four (4) inch minimum. The staples shall be made of wire, 0.091-inch in diameter or greater, "U" shaped with legs 10-inches in length and a 1¹/₂-inch crown. The staples shall be driven vertically into the ground, spaced approximately two (2) linear feet apart, on each side, and one row in the center alternately spaced between each size.
5. Upper and lower ends of the matting shall be buried to a depth of four (4) inches in a trench.
6. Erosion stops shall be created every 25-feet by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be four (4) inches below the ground surface. Staple on both sides of fold.
7. Where the matting must be cut or more than one roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of four (4) inches. Overlap lower end of upstream roll four (4) inches past edge of downstream roll and staple.
8. To ensure full contact with soil surface, roll matting with a roller weighing 100-pounds per foot of width perpendicular to flow direction after seeding, placing matting and stapling.
9. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

I. Temporary Mulching

1. Straw mulch shall be applied at rate of 100 lbs/1,000 ft² and tackified with latex acrylic copolymer at a rate of 1 gal/1,000 ft² diluted in a ratio of 30 parts water to one part latex acrylic copolymer mix.

MAINTENANCE AND INSPECTIONSA. Inspections

1. Contractor shall make a visual inspection of all sedimentation control devices once per week and promptly after every rain event exceeding ¼-inch. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas or into the vent trench, Contractor shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device Maintenance1. Triangular Filter Dikes

- a. Realign berms as needed to prevent gaps between the sections.
- b. Accumulated silt should be removed after each rainfall event, and disposed of in a manner which shall not cause additional siltation.

2. Rock Berm

- a. Remove sediment and other debris when buildup reaches six (6) inches and dispose of the accumulated silt in an approved manner.
- b. Repair any loose wire sheathing.
- c. Reshape as needed.
- d. Replace berm when the structure ceases to function as intended due to silt accumulation among the rocks, washout, construction traffic damage, etc.

3. Silt Fences

- a. Remove accumulated sediment when buildup reaches six (6) inches.
- b. Replace damaged fabric, or patch with a two (2) foot minimum overlap.
- c. Replace or repair any sections crushed or collapsed in the course of construction activity.
- d. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

4. Curb Inlet Protection

- a. Repair any damaged fabric, or patch with a two (2) foot minimum overlap.
- b. Replace any damaged sandbags.
- c. Remove accumulated sediment.

5. Stabilized Construction Entrance
 - a. Periodic top dressing with additional stone may be required as conditions demand to prevent tracking or flowing of sediment onto public rights-of-way.
 - c. Cleanout any measures used to trap sediment as needed.
 - d. All sediment spilled, dropped, washed or tracked on to public rights-of-way should be removed immediately by the Contractor.
 - e. When necessary, wheels should be cleaned to remove sediment prior to entrance onto public rights-of-way.
 - f. When washing is required, it should be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin.
 - g. All sediment should be prevented from entering any storm drain, ditch or water course by using approved methods.
6. Tree Protection – Chain Link Fence
 - a. Repair or replace any chain link fence damaged by construction activities.
7. Tree Protection – Wood Slats
 - a. Repair or replace any wood slats damaged by construction activities.
8. Excelsior Matting
 - a. Replace matting as needed to prevent erosion from occurring.
9. Temporary Mulch
 - a. Replace mulch as needed to prevent erosion from occurring.

G6.08 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Plans.

G6.09 PAYMENT

- A. Silt fence and rock berm will be paid per linear foot installed as listed in the Proposal and Bid Schedule.
- B. Stabilized Construction Entrance will be paid per each installed as listed in the Proposal and Bid Schedule.
- C. Tree protection will be paid per each installed as listed in the Proposal and Bid Schedule.
- D. Erosion Control Blankets will be paid per square yard as listed in the Proposal and Bid Schedule.

- E. Triangular Filter Dikes will be paid per linear foot as listed in the Proposal and Bid Schedule.
- F. No separate payment will be made for all other work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION G7 – LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL

G7.01 SCOPE OF WORK

- A. This specification covers the requirements to provide erosion control and place topsoil, finish grade, apply fertilizer, hydraulically apply seed and mulch and maintain all seeded areas as shown on the Plans and as specified herein, including all areas disturbed by the Contractor.

G7.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, samples of all materials to be used and all other pertinent data to illustrate conformance to the specification found within.

G7.03 TOPSOIL

- A. Topsoil shall be fertile, friable, natural topsoil typical of topsoil of the locality and shall be obtained from a well drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants or their roots, sticks, clay, peat and other extraneous matter and shall not be delivered to the site or used while in a frozen or muddy condition. Topsoil as delivered to the site or stockpiled shall have pH between 6.0 and 7.0 and shall contain not less than three (3) percent organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees Celsius. The topsoil shall meet the following mechanical analysis:

	<u>Percentage Passing</u>
1-inch screen opening	100
No. 10 mesh	95 - 100
No. 270 mesh	35 - 75
0.002 mm*	5 - 25

* Clay size fraction determined by pipette or hydrometer analysis.

- B. At least 10 days prior to anticipated start of topsoiling operations, a one pint sample of topsoil material shall be delivered by the Contractor to a laboratory for testing and approval. All testing shall be at the sole expense of the Contractor. Based on tests performed by the laboratory, the topsoil shall be identified as acceptable, acceptable with certain fertilizer and limestone applications or unacceptable. If the topsoil is found acceptable the fertilizer and lime requirements will be as specified or as recommended by the laboratory. If the topsoil is found unacceptable, the Contractor shall be responsible for identifying another source of topsoil and shall incur all expenses associated with testing additional samples. All topsoil incorporated into the site work shall match the sample provided to the laboratory for testing. Topsoil stockpiled under other Sections of these Specifications may be used subject to the testing and approval outlined above. Contractor will be responsible for screening stockpiled topsoil and providing additional topsoil as required at his/her own expense.

- C. Lime shall be ground limestone containing not less than 85-percent calcium and magnesium carbonates and be ground to such fineness that at least 50-percent shall pass a 100-mesh sieve and at least 90-percent shall pass a 20-mesh sieve.
- D. All planting shall be done between May 1 and September 15, except as specifically authorized in writing. If planting is authorized to be done outside the dates specified, the seed shall be planted with the addition of winter fescue (Kentucky 31) at a rate of 100 lbs. per acre.
- E. The seed shall be furnished and delivered premixed in the proportions specified within. A Manufacturer's Certificate of Compliance to the specified mixes shall be submitted by the Manufacturers for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
- F. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.
- G. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air-dry weight content and not contain in excess of 10-percent moisture.
- H. Excelsior matting blanket installed in all drainage swales and ditches shall be in accordance with Section G6 - SEDIMENTATION AND TEMPORARY EROSION CONTROL.

G7.04

APPLICATION OF TOPSOIL

- A. Unless otherwise shown on the plans, topsoil shall be placed to a minimum compacted depth of six (6) inches on all parts of the site not covered with structures, pavement, or existing woodland.
- B. For all areas to be seeded:
 - 1. Fertilizer (10-20-10) shall be applied at the rate of 30-lbs. per 1,000-sq. ft. or as determined by the soil test.
 - 2. Seed shall be applied at the rate of five (5) lbs. per 1,000-sq. ft.
 - 3. Fiber mulch shall be applied at the rate of 40-lbs. per 1,000-sq. ft.
- C. After the topsoil is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over the loam surface and thoroughly incorporated by heavy raking to at least one half the depth of topsoil.
- D. The application of fertilizer may be performed hydraulically in one operation with hydroseeding and fiber mulching. The Contractor is responsible for cleaning all structures and paved areas of unwanted deposits of the hydroseeded mixture.

INSTALLATION OF TOPSOIL

- A. Previously established grades, as shown on plans shall be maintained in a true and even condition.
- B. Subgrade shall be prepared by tilling prior to placement of topsoil to obtain a more satisfactory bond between the two (2) layers. Tillage operations shall be across the slope. Tillage shall not take place on slopes steeper than two (2) horizontal to one vertical or where tillage equipment cannot be operated. Tillage shall be accomplished by disking or harrowing to a depth of nine (9) inches parallel to contours. Tillage shall not be performed when the subgrade is frozen, excessively wet, extremely dry or in other conditions which would not permit tillage. The subgrade shall be raked and all rubbish, sticks, roots and stones larger than two (2) inches shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with loam.
- C. Topsoil shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades and elevations indicated. No loam shall be spread in water or while frozen or muddy.
- D. After topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All stiff clods, lumps, roots, litter and other foreign material shall be removed from the loamed area and disposed of by the Contractor. The areas shall also be free of smaller stones, in excessive quantities, as determined by the Engineer or the City. The whole surface shall then be rolled with a hand roller weighing not more than 100-lbs per foot of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be regraded and rolled until a smooth and even finished grade is created.
- E. Seeding shall be done within 10 days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Contractor shall furnish the Engineer with a certified statement as to the number of pounds of materials to be used per 100-gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Contractor's hydroseeder. Upon completion of seeding operations, the Contractor shall furnish the Engineer and the City with a certified statement on the actual quantity of solution applied.
- F. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainageways, the Contractor shall carry out seeding and mulching as soon as he/she has satisfactorily completed a unit or portion of the project. A unit or portion of the project shall be determined by the City or Engineer. When protection of newly loamed and graded areas is necessary at a time which is outside of the normal seeding season, the Contractor shall protect those areas by what ever means necessary as approved by the Engineer and the City and shall be responsible for prevention of siltation in the areas beyond the limit of work.
- G. When newly graded subgrade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, the Contractor shall protect those areas against erosion and washouts in accordance with Section G6 - SEDIMENTATION AND TEMPORARY EROSION CONTROL, or by other measures as approved by the Engineer and the City. Prior to application of topsoil, any such materials applied for erosion

control shall be removed or thoroughly incorporated into the subgrade by disking. Fertilizer shall be applied prior to spreading of topsoil.

- H. On slopes, the Contractor shall provide against washouts by a method approved by the Engineer and the City. Any washout which occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.

G7.06

HYDROMULCHING

- A. Fertilizer: 18-18-5, (Nitrogen, Phosphoric Acid, Potash) slow release granular at a rate of 25-lbs per 1,000-sq. ft.
- B. Water: The Contractor shall provide water necessary for grass planting and maintenance until acceptance by the City.
- C. Planting Seasons: Grass planting by sodding, sprigging, or hydromulching shall normally be done between May 1 and September 15.
- D. Hydromulching General
1. Submit Manufacturer's product specifications and guaranteed purity analysis for fertilizer.
 2. Product Delivery, Storage and Handling
 - a. Deliver fertilizer to site in original unopened containers bearing Manufacturer's guaranteed chemical analysis, name, trademark and conformance to State Law.
 - b. Store fertilizer in a dry location and protect from weather.
 3. Guaranty and Replacement
 - a. Provide guaranty for a period of one year after final completion and acceptance of project, that the installed grass areas be at least the quality and condition as during acceptance.
 - b. Rehydromulch unacceptable areas during the guaranty period. Guaranty shall not include damage or loss of lawn due to acts of God, acts of vandalism or negligence on the part of the City.
- E. Native Grass Hydromulching-Products
1. Grass Seed: Common Bermuda grass, hulled, minimum 82% pure live seed. All grass seed shall be free from noxious weed, grade "A" recent crop, recleaned and treated with appropriate fungicide at time of mixing. Seed shall be furnished in sealed, standard containers with dealer's guaranteed analysis.
 2. Mulch: Conwed regular wood fiber mulch or approved equal.
 3. Fertilizer: 18-18-5, water-soluble or an approved equal.
 4. Topsoil: Supply high quality imported topsoil of loamy character to the limits shown on the Plans, high in humus and organic content from local agriculture source. Topsoil to be

free from clay, lumps, coarse sands, stones, roots and other foreign matter. There shall be no toxic amounts of acid or alkaline elements. Soil to be used for on-site mixing of backfill.

F. Native Grass Hydromulching-Execution

1. Preparation: Fine grade to final elevation removing any debris and insuring the seedbed is smooth.
2. Installation: Use a hydromulcher (sprayer) and apply the mixture at the following rate (mix in accordance with Manufacturer's recommendations).
 - a. Hydromulch mixture shall contain 2.5-lbs. of common Bermuda grass seed per 1,000-sq. ft. hydromulch applied.
 - b. Mulch – 60-lbs. per 1,000-sq. ft.
 - c. Fertilizer – 25-lbs (18-18-5) per 1,000-sq. ft.
3. General Maintenance
 - a. Water the completed installation as necessary to insure germination of grass.
 - b. Maintain grass areas until complete germination and establishment of all areas.
 - c. Correct defective work as soon as apparent. Maintenance shall include, but not be limited to, weeding and fertilizing.
 - d. Clean up: Remove trash and debris from the site.
 - e. Acceptance: Substantial completion inspection to determine acceptance of grass areas will be made by the City after complete germination and coverage has been attained.

G7.07 MAINTENANCE OF DEVELOPING GRASS

- A. The Contractor shall water and maintain all grassed areas until final acceptance. He shall also re-fertilize at the rate of one pound of nitrogen and one pound of phosphorous per 1,000-sq. ft. every 60 days until the grass is accepted.
- B. Areas which, due to settling or improper leveling, do not have positive drainage shall be re-leveled with topsoil and replanted with grass.
- C. Areas damaged by erosion, vehicle ruts and similar damage shall be re-leveled with topsoil and replanted. Finished ground surface shall be sufficiently smooth and level to facilitate mowing.

G7.08 ACCEPTANCE

- A. Work under this section shall be considered acceptable when finish graded surfaces are level and well-drained, when there are no bare spots larger than three (3) square feet, when no more than 10 percent of the total area has bare spots larger than one square foot, when not more than 15 bare spots larger than six (6) inches square and the grass is at least two (2) inches high, and when other requirements listed herein are met.

- B. Acceptance of work normally coincides with final acceptance of the entire project. However, seasonal factors may be cause for delay in grass planting, development, and acceptance.
- C. The City will accept responsibility for normal maintenance when grass is accepted. However, the Contractor shall remain responsible for any subsequent grass damage that he causes and for warranty of materials and workmanship for a period of not less than one year from the time of acceptance.
- D. The Contractor shall furnish full and complete written instruction for maintenance of the seeded areas to the City at the time of acceptance.

G7.09

PAYMENT

- A. No separate payment will be made for finish grading, placement of topsoil or grass planting and fertilizing. All related costs shall be included in the proper item of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION G8 – MISCELLANEOUS WORK AND CLEANUP

G8.01 SCOPE OF WORK

- A. This specification covers the requirements to do the miscellaneous work not specified in other sections but obviously necessary for the proper completion of the work as shown on the Plans.

G8.02 SUBMITTALS

- A. Within 10 days after the Notice to Proceed, the Contractor shall submit to the Engineer, in triplicate, a breakdown of any lump sum included in the Proposal and Bid Form. This breakdown shall be subject to approval by the Engineer and when so approved shall become the basis for determining progress payments and for negotiation of change orders, if required. In some contracts, a lump sum item shall not be provided in the Proposal and Bid Form and shall be subsidiary to the other work items.

G8.03 GENERAL

- A. When applicable, the Contractor will perform the work in accordance with other sections of this Specification. When no applicable specification exists, the Contractor shall perform the work in accordance with the best modern practice and/or as directed by the Engineer.
- B. The work of this Section includes, but is not limited to, the following:
 - 1. Crossing and Relocating Existing Utilities.
 - 2. Restoring Driveways, Fences and Curbing.
 - 3. Cleaning Up.
 - 4. Incidental Work.
 - 5. Restoring Easements and Rights-of-Way.

G8.04 CROSSING AND RELOCATING EXISTING UTILITIES

- A. This item includes any extra work required in crossing culverts, water courses including streams and drainage ditches, drains, gas mains, water mains and water services and other utilities. This work shall include but is not limited to the following: bracing, hand excavation and backfill (except screened gravel) and any other work required for crossing the utility or obstruction not included for payment in other items of this specification. Notification of Utility Companies shall be the Contractor's responsibility.
- B. In locations where existing utilities cannot be crossed without interfering with the construction of the work as shown on the Plans, the Contractor shall remove and relocate the utility as directed by the Engineer or Representative of the City or cooperate with the Utility Companies concerned if they relocate their own utility.

- C. At pipe crossings and where designated by the Plans, the Contractor shall furnish and place crushed stone bedding so that the existing utility or pipe is firmly supported for its entire exposed length. The bedding shall extend to the mid-diameter of the pipe crossed.

G8.05 RESTORING OF DRIVEWAYS AND FENCES

- A. Existing public and private driveways disturbed by the construction shall be replaced. Paved drives shall be repaved to the limits and thicknesses existing prior to construction. Gravel dirt roads and drives shall be replaced and regraded.
- B. Fences in the vicinity of the work shall be protected from damage. If damaged, fences shall be replaced in condition equal to that prior to being damaged and the work shall be satisfactory to the City.

G8.06 CLEANING UP

- A. The Contractor shall remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall restore the site of the work to a neat and orderly condition. All stored materials shall be kept in a neat manner, secured and protected from the public.

G8.07 INCIDENTAL WORK

- A. Do all incidental work not otherwise specified, but obviously necessary to the proper completion of the Contract as specified and as shown on the Plans.

G8.08 RESTORING THE EASEMENTS AND RIGHTS-OF-WAY

- A. Portions of the work may be within easements through private property. The Contractor shall be responsible for all damage to private property due to his/her operations. The Contractor shall protect from injury all walls, fences, cultivated shrubbery and vegetables, fruit trees, pavement, underground facilities, such as water pipes, or other utilities which may be encountered along the easement. If removal and replacement are required, it shall be done in a workmanlike manner so that replacement is equivalent to that which existed prior to construction.
- B. Existing lawn and sod surfaces damaged by construction in easements shall be replaced. The Contractor may cut and replace the lawn and sod, or may restore the areas with an equivalent depth and quality of loam, seeded and fertilized as specified in Section G7 - LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL if acceptable to the owner of the private property and the City. These areas shall be maintained and re-seeded or re-sodded at the option of the owner of the private property and the City, if necessary, until all work under this Contract has been completed and accepted. Any additional work required to restore easements to their original condition shall be performed by the Contractor.

G8.09 PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATION

SECTION G9-STRUCTURAL EXCAVATION

G9.01 SCOPE OF WORK

- A. This specification covers the requirements for excavation for the placing of structures, except pipe, for the disposal of such excavated material, and for the backfilling around completed structures to the level of the original ground.

G9.02 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards or requested by the Engineer or the City.

G9.03 CONSTRUCTION METHODS

- A. Excavation shall be done in accordance with the lines and depths indicated on the Plans or as established by the City. Unless otherwise specified on the Plans or permitted by the City no excavation shall be made outside a vertical plane three (3) feet from the footing lines and parallel thereto. When caissons are provided, no excavation will be permitted outside the outer faces of the caissons.
- B. To permit the City to judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores to determine the character of the subgrade materials. The maximum depth of soundings or cores will in general, not exceed five (5) feet below the proposed footing grade. It is the intent of this provision that soundings shall be made at the time the excavation in each foundation is approximately complete.
- C. Excavations shall conform to elevations shown on the Plans, or raised or lowered by written order of the City, when such alterations are judged proper. When deemed necessary to increase or decrease the plan depth of footings, the alterations in the details of the structure shall be as directed by the City. The City shall have the right to substitute revised details resulting from consideration of changes in the design conditions.
- D. When a structure is to be placed on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final excavation to grade shall not be performed until just before the footing is placed.
- E. Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for its rehandling during the backfilling operations and with the approval of the City.
- F. For all single and multiple box culverts, pipe culverts, pipe arch culverts, and box sewers of all types, where the soil encountered at established footing grade is a quicksand, muck, or similar unstable material, the following procedure shall be used unless other methods are called for on the Plans:
 - 1. The depth to which unstable material is removed will be determined by the City. The depth will not exceed two (2) feet below the footing of culverts that are two (2) feet or more in height, and will not exceed the height of culverts of those less than two (2) feet high. Excavation shall be carried at least one (1) foot horizontally beyond the limits of the structure on all sides. All unstable soil removed shall be replaced with suitable stable material, in uniform layers of suitable depth for compaction as directed by the City. Each layer shall be wetted; if necessary, and compacted by rolling or tamping as required to provide a stable foundation for the structure. Soil which has sufficient stability to properly sustain the adjacent sections of the roadway embankment will be considered a suitable foundation material.
 - 2. When in the opinion of the City, it is not feasible to construct a stable footing as outlined above, the Contractor shall construct it by the use of special materials, such as flexible

base, cement stabilized base, cement stabilized backfill or other material, as directed by the City.

- G. When the material encountered at footing grade of a culvert is found to be partially rock, or incompressible material, and partially a compressible soil which is satisfactory for the foundation, the incompressible material shall be removed for a depth of six (6) inches below the footing grade and backfilled with a compressible material similar to that used for the rest of the structure.

G9.04

BACKFILLING

- A. General: As soon as practicable, all portions of excavation not occupied by the permanent structure shall be backfilled. Back-fill material shall be free from large or frozen lumps, wood or other extraneous material.
1. That portion of backfill which will not support any portion of completed roadbed or embankment shall be placed in layers not more than 10-inches in depth (loose measurement) and shall be compacted to a density comparable with the adjacent, undisturbed material.
 2. That portion of the backfill which will support any portion of the roadbed or embankment or is within two (2) feet of the roadbed or embankment shall be placed in uniform layers not to exceed six (6) inches in depth (loose measurement) and each layer compacted to the density specified for the appropriate material. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to that density by means of mechanical tamps, except that the use of rolling equipment of the type generally used in compacting embankments will be permitted on portions which are accessible to such equipment. All portions of embankment too close to any portion of a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted in the same manner as specified above for backfill material. These provisions require the mechanical compaction, by means of either rolling equipment or mechanical tamps, of all backfill and embankment adjoining the exterior walls and wingwalls of culverts. Unless otherwise provided by the Plans or Special Conditions, hand tamping will not be accepted as an alternate for mechanical compaction. As a general rule, material used in filling or backfilling the portions described in this paragraph shall be an earth free of any appreciable amount of gravel or stone particles more than four (4) inches in greatest dimension and of a gradation that permits thorough compaction. The percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density. When required by the Plans or by written order of the City, cement stabilized material shall be used for backfilling.
 3. All portions of fill and backfill described in the preceding paragraph shall be compacted to the same density requirements specified for the adjoining sections of embankment in accordance with the governing specifications therefore.
 4. Where no embankment is involved on the Project and no specifications therefor are included in the Contract, all backfill shall be compacted to a density comparable with the adjacent undisturbed material.
 5. Care shall be taken to prevent any wedging action of backfill against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such action.
 6. Backfilling shall not proceed prior to inspection and approval of the inspector.

G9.05

PIPE CULVERTS

- A. The following requirements shall apply to the backfilling of pipe culverts in addition to the pertinent portions of the general requirements given in the preceding and in pipe bedding Standards.
 - 1. Backfilling shall be continued in this manner to the elevation of the top of the pipe. Special care shall be taken to secure thorough compaction of the material placed under the haunches of the pipe. In the case of pipe in trenches, that portion of the backfill above the top of the pipe which supports embankment or the roadbed or is within two (2) feet of the roadbed or embankment shall receive mechanical compacting as specified, and the portion which will not support any portion of embankment or roadbed shall be placed in layers not more than ten (10) inches in depth (loose measurement) and shall be compacted by whatever means the Contractor chooses, to a density comparable with the adjacent, undisturbed material.

G9.06

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END SECTION

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TECHNICAL SPECIFICATIONS

SECTION SD1 - HOT MIX ASPHALTIC CONCRETE PAVEMENT

SD1.01 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing hot mix asphaltic concrete as shown in the Plans and specified within. Construction shall include a base course, a level-up course, a surface course or any combination of these courses as shown on the Plans, each course being composed of a compacted mixture of aggregate and asphalt mixed hot in a mixing plant, in accordance with the details shown on the Plans and the requirements herein.

SD1.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature including mix design, aggregate source, aggregate gradation, aggregate type, and all other pertinent data to illustrate conformance to the specification found within.

SD1.03 MATERIALS

- A. The mineral aggregate shall be composed of a coarse aggregate, a fine aggregate, and if required, a mineral filler. Coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall be stone, crushed slag, crushed gravel, or gravel. Fine aggregate shall be that part passing the No. 10 sieve and shall consist of sand or screenings. Mineral filler shall consist of dry stone dust, Portland cement, or fly ash. Mineral aggregate shall meet the requirements of Item 340, Texas Department of Transportation, Standard Specifications for Construction of Highways, Streets and Bridges. The plasticity index of fine aggregate portion passing the No. 40 sieve shall not be more than six (6).

SD1.04 ASPHALTIC MATERIAL

- A. Asphalt for the paving mixture shall meet the requirements of Texas Department of Transportation, Item 300 of the Standard Specifications for Construction of Highways, Streets and Bridges. The grade of asphalt used shall be designated by the Engineer or the City after design tests have been made using the mineral aggregate to be used in the job.

SD1.05 TACK COAT

- A. Tack coat shall be in accordance with Texas Department of Transportation, Item 300 of the Standard Specifications for Construction of Highways, Streets and Bridges. Asphaltic material shall be approved by the Engineer or the City.

SD1.06 TYPES OF ASPHALTIC CONCRETE

- A. The mixture shall be designed and tested in accordance with the current Texas Department of Transportation, Standard Specifications for Construction of Highways, Streets and Bridges, Item 340, Type D, and will have a laboratory density of not less than 94.5% nor more than 97.5%, and a stability of not less than 35.
- B. The asphaltic material shall form from four to eight (4-8) percent of the mixture by weight or from nine to nineteen (9-19) percent of the mixture by volume.

SD1.07 EQUIPMENT

- A. Spreading and Finishing Machine

1. The spreading and finishing machine shall be a type approved by the Engineer, shall be capable of producing a surface that will meet the requirements of the typical cross section and the surface test, when required, and when the mixture is dumped directly into the finishing machine, shall have adequate power to propel the delivery vehicles in a satisfactory manner. The finishing machine shall be equipped with a flexible spring and/or hydraulic-type hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.
2. The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel in such a manner as to obtain the desired lines and grades without resorting to hand-finishing will not be allowed. Unless otherwise permitted by the Plans, vehicles of the semi-trailer type are specifically prohibited from dumping directly into the finishing machine while in contact with the finishing machine. Vehicles dumping directly or indirectly into the finishing machine shall be so designed and equipped that unloading into the finishing machine can be mechanically and/or automatically operated in such a manner that overloading the finishing machine being used cannot occur and the required lines and grades will be obtained without resorting to hand-finishing.
3. Dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with loading equipment will be permitted, provided that the loading equipment is constructed and operated in such manner that substantially all of the mixture deposited on the roadbed is picked up and loaded in the finishing machine without contamination of foreign material of the mixture, and excessive temperature loss is not encountered. The loading equipment will be so designed and operated that the finishing machine being loaded will obtain the required line, grade, and surface without resorting to hand-finishing. Any operation of the loading equipment resulting in the accumulation and subsequent shedding of this accumulated material into the asphaltic mixture will not be permitted.

B. Rolling Equipment

1. Rolling equipment shall consist of pneumatic tire rollers, two-axle tandem roller weighing not less than eight (8) tons, three-wheel roller weighing not less than 10-tons, three-axle tandem roller weighing not less than 10-tons, and trench rollers having a 20-inch wheeldrive and producing 325 pounds per linear inch of roller width at a speed of 1.8 miles per hour in low gear.

C. Straight Edges and Templates

1. The Contractor shall provide an acceptable 10-foot straight edge for surface testing.

SD1.08

CONSTRUCTION METHODS

- A. The prime coat, tack coat or the asphaltic mixture, when placed with a spreading and finishing machine, shall not be placed when the air temperature is below 50 degrees F and is falling, but it may be placed when the air temperature is above 40 degrees F and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the prime coat, tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the Engineer or the City, are suitable.

B. Prime Coat

1. A prime coat is required, and shall be applied at the rate determined by the Engineer but not less than 0.2-gallons per square yard of MC-1 asphalt. The asphaltic concrete shall not be applied on a previously primed flexible base until the primed base has completely cured to the satisfaction of the Engineer and the City.

C. Transporting Asphaltic Concrete

1. The asphaltic mixture, prepared as directed above, shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be

arranged so that all material delivered may be placed, and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers and insulating of the truck bodies may be required. The inside of the truck body may be given a light coating of oil, lime slurry or other material satisfactory to the Engineer and the City, if necessary, to prevent mixture from adhering to the body.

D. Placing

1. Generally, the asphaltic mixture shall be dumped and spread on the approved prepared surface with the specified spreading and finishing machine, in such manner that when properly compacted, the finished pavement will be smooth, of uniform density, and will meet the requirements of the typical cross-sections and the surface tests. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures. When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer or the City, provided a satisfactory surface can be obtained by other approved methods.

E. Compacting

1. Rolling: The pavement shall be compressed thoroughly and uniformly with the specified roller and/or other approved rollers. Rolling with the three-wheel and tandem rollers shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the rear wheel. Alternate trips of the roller shall be slightly different in length. Rolling with pneumatic-tire roller shall be done as directed by the Engineer. Rolling shall be continued until no further compression can be obtained and all roller marks are eliminated. One (1) tandem roller, one (1) pneumatic-tire roller, and at least one (1) three-wheel roller, as specified above, shall be provided for each job. If the Contractor elects, he may substitute the three-axle tandem roller for the two-axle tandem roller and/or the three-wheel roller; but in no case shall less than three rollers be in use on each job. Additional rollers shall be provided if needed. The motion of the roller shall be slow enough at all times to avoid displacement of the mixture. If any displacement occurs, it shall be corrected at once by the use of rakes and of fresh mixtures where required. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. All rollers must be in good mechanical condition. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease, or other foreign matter on the pavement, either when the rollers are in operation or when standing. Regardless of the method used for compaction, all rolling to achieve specified density shall cease when the Hot Mix Asphaltic Mixture drops below 175°F (80°C).
2. In-Place Density: The Hot Mix Asphaltic mixture shall be tested daily at the project site for conformance to specification requirements. Unless directed otherwise by the Engineer or designated representative, a bag sample and a core or section will be obtained for each 2000 square yards or portion of paving each day, with a minimum of three bag samples and three cores for each day's paving.

Bag samples shall be taken during lay-down operations. The primary sampling point for the bag samples shall be from the windrow if a windrow elevator is used. If a windrow elevator is not used, the sample shall be taken from the middle of the paving machine hopper. Gradation, asphalt content and stability value of the hot mix asphaltic mixture shall be reported for each of the bag samples. The stability value reported for each of the bag samples shall be the average of three (3) tests per bag.

Pavement thickness and in-place density shall be determined from the field cores or sections. The average of all hot mix asphaltic concrete pavement core or section thicknesses shall meet the minimum thickness of 2.0". No individual core or section thickness deficiency may be greater than 0.2 inches. Pavement that does not meet the

thickness specification shall be removed and replaced as outlined below. The in-place density tests are intended for compaction-control tests and will be tested according to Test Method Tex-207-F. The core or section densities shall average from 91.0% to 96.0% of the maximum theoretical density except that the minimum acceptable density of an individual sample is 89.0% or the maximum acceptable density of an individual sample is 97.0%. There will be no two consecutive core or section densities below 91.0% or above 96.0%. Asphalt pavement represented by a density less than 89.0%, more than 97.0% or two consecutive densities less than 91.0% shall be removed and replaced.

Any pavement to be removed and replaced will be removed and replaced from curb to curb or edge of asphalt to edge of asphalt at the contractor's expense. Additional density tests shall be used to delineate the limits of the in-place hot mix asphaltic pavement that does not meet the density specification and the results of the tests shall not be used in the calculation of the overall average density. Protocol to assess the area of asphalt pavement removal and replacement shall start between the failing density or two consecutive densities that are less than 91.0% and the next passing density to either side of the failing pavement. Additional cores or sections will be required to quantify the area of replacement back to an in-place density of 91.0%. Backscattering (nuclear densities) shall not be used to determine the actual density of asphaltic pavement.

Pavements with low-density results may be retested; but the pavement shall not receive any additional compactive effort.

Final acceptance of the pavements shall be the responsibility of the Engineer.

3. Hand-Tamping: The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller or in such position as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

F. Surface Tests

1. The surface of the pavement, after compaction, shall be smooth and true to the established line, grade, and cross-section, and when tested with a 10-foot straightedge placed parallel to the centerline of the roadway or tested by other equivalent and acceptable means, except as provided herein, the maximum deviation shall not exceed 1/4-inch in 10-feet, and any point in the surface not meeting this requirement shall be corrected.

SD1.09 ROADS DAMAGED BY CONSTRUCTION

- A. The Contractor shall reconstruct existing asphalt paved roads which are damaged as a result of construction of this project at no additional cost to the City. Reconstruction shall consist of reconstructing the road to an "as new condition" to the existing pavement cross section. The Contractor may use existing base material, adding new base material as needed. Contractor shall compact and reshape road subgrade to existing grade. The subbase and base shall be compacted in accordance with these specifications. The Contractor shall install at least two (2) inches of hot-mix asphalt pavement in accordance with these specifications.

SD1.10 MEASUREMENT AND PAYMENT

- A. Payment for furnished and installed hot mix asphaltic concrete pavement shall be paid according to the unit price per square yard in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the hot mix asphaltic concrete shall be subsidiary to this item.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION SD2 – ROADWAY EXCAVATION

SD2.01 SCOPE OF WORK

- A. This specification covers the requirements for shaping and finishing of all earthwork on the entire length of roadway, and approaches to same, in conformity with the required lines, grades and typical cross sections and in accordance with specification requirements herein outlined. Compaction shall conform to the method of “Density Control” and/or “Ordinary Compaction” as shown on the Plans and Specifications.

SD2.02 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards, or requested by the City or Engineer.

SD2.03 CONSTRUCTION METHODS

- A. All roadway excavation and corresponding embankment construction shall be performed as specified herein and in Section S3- EMBANKMENT, and the completed roadway shall conform to the established alignment, grades and cross sections.
- B. All suitable excavated materials shall be utilized, insofar as practicable, in constructing the required roadway sections. Unsuitable roadway excavation and roadway excavation in excess of that needed for the construction of the roadway shall be disposed of outside the limits of the right-of-way. Unsuitable material encountered below subgrade elevation in roadway cuts, shall be removed and replaced, as directed by the Representative of the City with material from the roadway excavation or with other suitable material.
- C. During construction, the roadbed and ditches shall be maintained in such condition as to insure proper drainage at all times and ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section. Soils with plasticity index (PI) of 20 or more shall be stabilized with an amount of lime adequate to reduce the PI to less than 20. Type A Grade 1 base material may be used with a minimum ratio of 1 to 1, in lieu of lime. If using lime treatment refer to Item 260 in the Texas Department of Transportation’s “Standard Specifications for Construction of Highways, Streets and Bridges”.

NOTE: ALL UNDERGROUND UTILITIES SHALL BE INSTALLED PRIOR TO ANY LIME TREATMENT OR FLEXIBLE BASE PLACEMENT.

NOTE: Blue-tops will be set on the center and crown of the streets or roads at every 50-foot station. These grade stakes will be to finished grade and visible for inspection before flexible base is applied.

SD2.04 PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification. Select back fill shall be paid for according to the unit price per cubic yard according to the appropriate item, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION SD4 – FLEXIBLE BASE

(Crushed Stone)

SD4.01 SCOPE OF WORK

- A. This specification covers the requirements for the use of “Flexible Base (Crushed Stone)” for this project.

SD4.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature including binding material, additives, aggregate source, aggregate type, aggregate gradation and all other pertinent data to illustrate conformance to the specification found within.

SD4.03 GENERAL

- A. “Flexible Base (Crushed Stone)” shall consist of a foundation course for surface course or for other base courses; shall be composed of crusher-run broken stone; and shall be constructed as herein specified in one or more courses in conformity with the typical sections shown on Plans and to the lines and grades as established by the Plans.

SD4.04 MATERIAL

- A. The material shall be crushed and shall consist of durable particles of stone mixed with approved binding material. The material source shall be approved by the Representative of the City, and conform to the requirements as follows:
- B. When properly slaked and tested by standard Texas Department of Transportation laboratory methods, the flexible base material shall meet the following requirements:
- C. Physical requirements

- a. General. All types shall meet the physical requirements for the specified grade(s) as set forth in Table 1.

Additives, such as, but not limited to, lime, cement or fly ash, shall not be used to alter the soil constants or strengths shown in Table 1, unless otherwise shown on the Plans.

Unless otherwise shown on the Plans, the base material shall have a minimum Bar Linear Shrinkage of two (2) percent as determined by Test Method Tex-107-E, Part II.

- b. The flexible base shall be:
1. Type A. Type A material shall be crushed stone produced from oversized quarried aggregate, sized by crushing and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable for Type A material. No blending of sources and/or additive materials will be allowed in Type A material.

TABLE 1
PHYSICAL REQUIREMENTS

Grade 1	
Triaxial Class 1: Min. compressive strength, psi: 45 at 0 psi lateral pressure and 175 at 15 psi lateral pressure	
Master Grading	
1-3/4"	0
7/8"	10-35
3/8"	30-50
No. 4	45-65
No. 40	70-85

Grade 1	
Max LL	35
Max PI	10
Wet Ball Mill	
Max	40
Max increase in passing	
No. 40	20

1. Gradation requirements are percent retained on square sieves.
2. When a magnesium soundness value is shown on the Plans the material will be tested in accordance with Test Method Tex-411-A.

Sieve Analysis	Tex-110-E
Moisture-Density Determination	Tex-113-E
Roadway Density	Tex-115-E
Wet Ball Mill	Tex-116-E
Triaxial Tests (Part I or II as selected by the Engineer)	Tex-117-E
Particle Count	Tex-460-A, Part I

Samples for testing the base material for triaxial class, soil constants, gradation and wet ball mill will be taken prior to the compaction operations.

SD4.05 TOLERANCES

- A. The limits establishing reasonably close conformity with the specified gradation and plasticity index are defined by the following:
- B. The City may accept the material, providing not more than two (2) out of 10 consecutive gradation tests performed are outside the specified limit on any individual or combination of sieves by no more than five (5) percent and where no two (2) consecutive tests are outside the specified limit.
- C. The City may accept the material providing not more than 2 out of 10 consecutive plasticity index samples tested are outside the specified limit by no more than two (2) points and where no two (2) consecutive tests are outside the specified limit.

SD4.06 CONSTRUCTION METHODS

A. Preparation of Subgrade

1. The roadbed shall be excavated and shaped in conformity with the typical sections, lines and grades as shown on the Plans. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All holes, ruts and depressions shall be filled with approved material, and if required, the subgrade shall be thoroughly wetted with water and reshaped and rolled to the extent directed in order to place the subgrade in an acceptable condition to receive the base material. The surface of the

subgrade shall be finished to line and grade as established and in conformity with the typical section shown on the Plans, and any deviation in excess of ½-inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of work.

B. First Course

1. Immediately before placing the base material, the subgrade shall be checked as to conformity with grade and section.
2. The material shall be delivered in approved vehicles of a uniform capacity and it shall be the charge of the Contractor that the required amount of specified material shall be delivered in each 100-foot station. Material deposited upon the subgrade shall be spread and shaped the same day unless otherwise directed by the City in writing. In the event inclement weather or other unforeseen circumstances render impractical the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the City. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to typical sections as shown on the Plans. The base layer shall be constructed in lifts not exceeding six (6) inches compacted thickness with each course being of equal thickness. All areas and “nests” of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by the City.
3. The course shall be compacted by the method of compaction hereinafter specified as the “Density Control” method of compaction.
 - a. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as hereinafter specified under “Density”. In addition to the requirements specified for density, the full depth of flexible base shown on the Plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base is completed, density tests shall be taken every 750 square yards of roadbed surface or every 250 linear feet, whichever is the least. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical section shown on the Plans and to the established lines and grades. In that area on which pavement is to be placed, any deviation in excess of ¼-inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling. Should the base course, due to any reason or cause, lose the required stability, density and finish before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the Contractor. The base material shall be placed at the optimum moisture contents to $\pm 3\%$.

C. Succeeding Courses

1. Construction methods shall be the same as prescribed for the first course.

D. Density

1. When the “Density Control” method of compaction is used, each course of flexible base shall be compacted to the percent density indicated below. The testing will be as outlined in TEX 113E. It is the intent of this specification to provide in that part of the base included in the flexbase section as shown on the Plans immediately below the finished surface of the roadway, not less than 100 percent of the density as determined by the compaction ratio method. Field

density determination shall be made in accordance with approved methods.

SD4.07

NOTES

- A. Invoices showing total amount of flexible base delivered to each street or road shall be furnished to the City before asphalt is applied.
- B. Bluetops will be set on the center, crown and back of curb of the streets or roads every 50-foot station or sufficient to maintain line and grade. These grade stakes will be to finished grade and visible for inspection before asphalt is applied.

SD4.08

PAYMENT

- A. Payment for furnished and installed flexible base shall be paid according to the unit price per square yard in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the installation of flexible base shall be subsidiary to this item.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION SD5 - STRIPING

SD5.01 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing pavement markings as shown on the Plans and specified within.

SD5.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including material type, test data, and all other pertinent data to illustrate conformance to the specification found within.

SD5.03 MATERIALS

- A. All pavement markings shall be thermoplastic type materials that require heating to elevated temperatures for application. They shall conform to Texas Department of Transportation Materials Specification D-9-8220. Each container of thermoplastic material shall be clearly marked to indicate the color, weight, type of material, Manufacturer's name and the lot/batch number.

SD5.04 STREET SIGNS

- A. All signage sheeting shall be high intensity or better. All signage posts shall be 2.375" OD x .095" thin wall steel tubing. All signs shall have breakaway foundations. All signage shall meet the current edition of TMUTCD.

SD5.05 EQUIPMENT

- A. All equipment used to place pavement markings shall be maintained in a satisfactory condition. The equipment shall be able to place markings at a rate that will produce a uniform product meeting all the requirements set within item 666 of the standard specifications for Construction of Highways, Streets and Bridges. It shall be capable of placing linear markings up to eight (8) inches in width in a single pass and able to place a center line and no passing barrier line configuration of one (1) broken line with two (2) solid lines at the same time to the alignment and spacing shown on the Plans. Equipment shall be capable of placing lines with clean edges of a uniform cross section within a tolerance of $\frac{1}{8}$ of an inch per four (4) inches width of marking. It shall have an automatic cut-off device with manual operating capabilities to provide clean, reasonably square marking ends to the satisfaction of the Engineer or the City and provide a method of applying broken line in an approximate stripe-to-gap ratio of 10 to 30. The length of the stripe shall not be less than 10-feet or more than 10.5-feet. The total length of any stripe-gap cycle shall not be less than 39.5-feet or more than 40.5-feet. It shall provide a continuous mixing and agitation of the pavement marking material. The use of pans, aprons or similar appliances will not be permitted for longitudinal striping applications. Beads shall be applied by an automatic bead dispenser that is attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly as the marking is placed on the pavement surface. The bead dispenser shall have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment. A hand held thermometer shall be kept on the project during the placement of pavement markings capable of measuring the temperature of the pavement marking material.

SD5.06 CONSTRUCTION METHODS

- A. Pavement marking shall be applied with an approximate stripe-to-gap ratio of 10 to 30 when the application is broken line striping. The length of the broken stripe shall not be less than 10-feet nor more than 10.50-feet. The total length of any stripe-gap cycle shall not be less than 39.50-feet nor more than 40.50-feet.
- B. With prior approval from the City of Georgetown, pavement markings may be placed on roadways open to traffic. When markings are to be placed under traffic, a minimum of interference to the operation of the traffic flow shall be maintained. Traffic control shall be maintained as shown on the approved

Traffic Control Plan. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement.

- C. The deviation rate in pavement marking alignment shall not exceed one (1) inch per 200-feet of roadway and the maximum deviation shall not exceed two (2) inches nor shall any abrupt deviations be acceptable.
- D. Markings shall have a uniform cross section. The density and quality of the markings shall be uniform throughout their thickness. The applied markings shall have no more than five (5) percent, by area, of holes or voids and shall be free of blisters.
- E. Markings shall be reflectorized both internally and externally. Glass beads shall be applied to the materials at a uniform rate sufficient to achieve uniform and distinctive retroreflective characteristics when observed in accordance with Test Method Tex-828-B.
- F. Pavement markings that are not in alignment or sequence, as shown on the Plans or Standards, shall be removed and replaced at the sole expense of the Contractor.

SD5.07

SURFACE PREPARATION

- A. New Portland cement concrete surfaces shall be cleaned to remove curing membrane, dirt, grease, loose and/or flaking existing construction markings and other forms of contamination.
- B. Older Portland cement concrete surfaces and asphalt surfaces that exhibit loose and/or flaking existing markings shall be cleaned to remove all loose and flaking markings.
- C. All pavement on which pavement markings are to be placed shall be completely dry.

SD5.08

APPLICATION

- A. Unless otherwise shown on the Plans, Portland cement concrete surfaces and asphaltic surfaces that are three (3) years old or older shall be sealed by the use of paint type striping. The paint type markings shall be placed a minimum of two (2) and a maximum of 30 calendar days in advance of placing the thermoplastic type pavement markings. If the paint type markings become dirty for any reason prior to placing the thermoplastic type markings, they shall be cleaned by washing, brushing, compressed air or other means approved. The pavement and paint type marking shall both be thoroughly dry before any thermoplastic type markings are placed. The color of the paint type markings shall be the same as the thermoplastic type markings.
- B. Pavement markings shall not be applied when the temperature and moisture limitations are beyond the Manufacturer's recommendation. The minimum thickness for thermoplastic markings shall be 0.060-inches (60-mil) for edgeline markings and 0.090-inches (90-mil) for stop bars, legends, symbols, gore and centerline/no passing barrier line markings, when measured in accordance with Test Method Tex-854-B. The maximum thickness of all thermoplastic type markings shall be 0.180-inches (180 mil).
- C. All markings which do not meet the specifications found within or are not satisfactory to the striping plan, installation of the markings, or do not meet the requirements of the project, shall be removed and replaced at the sole expense of the Contractor. In the event that damage is done to the pavement surface in the replacement operation, the damage shall be corrected to the satisfaction of the City at the sole expense of the Contractor.

SD5.09

MEASUREMENT AND PAYMENT

- A. Payment for furnished and installed pavement markings shall be paid according to the unit price per linear foot in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the pavement markings shall be subsidiary to this item.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION WW1 – CONCRETE MANHOLES

WW1.01 SCOPE OF WORK

- A. This specification covers the requirements to install precast concrete manholes, frames and covers, and appurtenances as shown on the Plans and as specified herein.

WW1.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, shop drawings, product data, materials of construction, and details of installation shall be submitted in accordance with Section CIP10- SUBMITTALS. Submittals shall include the following: base sections, riser sections, eccentric conical top sections, flat slab tops, grade rings with notarized certificate indicating compliance with ASTM C478, pipe connection to manhole, manhole frame and cover with notarized certificate indicating compliance with ASTM A48, Class 30, method of repair for minor damage to precast concrete sections, manhole lining system.

B. Design Data

1. Precast concrete structures:

- a. Six (6) copies of sectional plan(s) and elevations showing dimensions and reinforcing steel placement.
- b. Six (6) copies of concrete design mix.

C. Test Reports

1. Precast concrete structures:

- a. Six (6) copies of concrete test cylinder reports from an approved testing laboratory certifying conformance with specifications.

WW1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Specification for Gray Iron Castings.
2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM C33 - Specification for Concrete Aggregates.
4. ASTM C150 - Standard Specification for Portland Cement.
5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
6. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.

B. American Concrete Institute (ACI)

1. ACI 318 - Building Code Requirements for Reinforced Concrete.
2. ACI 350R - Concrete Sanitary Engineering Structures.

C. American Association of State Highway and Transportation Officials (AASHTO)

1. Standard Specifications for Highway, Streets and Bridges.

D. Occupational Safety and Health Administration (OSHA)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

WW1.04 QUALITY ASSURANCE

A. All material shall be new and unused.

B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by Engineer or other City representative. Inspection may be made at place of Manufacture, at work site following delivery, or both.

C. Materials will be examined for compliance with ASTM specifications, these Specifications and approved Manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions(s), blisters, cracks and soundness.

D. Materials shall be rejected for failure to meet any Specification requirement. Rejection may occur at place of manufacture, at work site, or following installation. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to City.

E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by Engineer or the City.

WW1.05 PRODUCTS

A. Reference to a Manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials/equipment shall be the end products of one Manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and Manufacturer's service.

C. Provide lifting lugs or holes in each precast section for proper handling.

WW1.06 PRECAST CONCRETE MANHOLE SECTIONS

A. Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall conform to ASTM C478 and meet the following requirements:

1. Bottom slab thickness shall be 12-inches.

2. Top section shall be flat slab with a minimum clear opening of 32 ⁷/₈-inches diameter.

3. Base, riser and transition top sections shall have tongue and groove joints.

4. Sections shall be cured by an approved method.

5. Precast concrete sections shall be shipped after concrete has attained 3,000 psi compressive strength.

6. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum HS-20 loading plus earth load. Calculate earth load with a unit weight of 130 pounds per cubic foot.

7. Mark date of manufacture, name and trademark of Manufacturer on the inside of each precast section.

8. Construct and install precast concrete base as shown on the Plans.
 9. Provide integrally cast knock-out panels in precast concrete manhole sections at locations, and with sizes shown on Plans. Knock-out panels shall have no steel reinforcing.
- B. Manhole diameter shall be as shown on the Plans, but not less than the diameter of the largest connecting pipe plus two (2) feet.
- C. Pipe Sections
- Pipe sections shall conform to current specifications for Precast Reinforced Manhole Sections, ASTM Designation C478, with the following additions:
1. Pipe shall be machine made by a process which will provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which will assure a dense concrete in the finished product.
 2. Aggregates for the concrete shall consist of limestone aggregates in the proportion of at least 75% by weight of the total aggregates.
 3. Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM C76 for Class III pipe.
- D. Joints
1. Joints shall conform to the joint specifications in ASTM C478, C76, and ASTM C443. All manhole sections, including the bottom section, shall be furnished with "O-ring" type rubber gasket joints. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with mortar or an approved non-shrink grout on the inside and the outside of the manhole. Grade rings shall be mortared to each other and on the inside and outside to provide a waterproof seal.
- E. Manhole Steps
1. Unless specifically approved by the City, manhole steps shall not be provided.

WW1.07

MANHOLE FRAME AND COVER

- A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.
- B. Manhole covers shall have a diamond pattern, pickholes and the word SEWER as appropriate cast in three (3) inch letters. Manhole frame and covers shall be Neenah Foundry, Western Iron Works, Vulcan Foundry, or equal. Model numbers refer to Western Iron works products:
1. Manhole Frame and cover - WRM-36.

WW1.08 JOINTING PRECAST MANHOLE SECTIONS

- A. Seal tongue and groove joints of precast manhole sections with rubber "O"-ring gasket. O-ring gasket shall conform to ASTM C443.
- B. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

WW1.09 PIPE CONNECTIONS TO MANHOLE

- A. Connect pipe to manhole in the following ways:
 - 1. Flexible sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PSX Press-Seal Gasket or equal.
 - 2. Compression gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok, or equal.

WW1.10 INSTALLATION

- A. Manhole Installation
 - 1. Manholes shall be constructed to the dimensions shown on the Plans and as specified herein. Protect all work against flooding and flotation.
 - 2. Place manhole base on a bed of screened gravel eight (8) inches in depth as shown on the Plans. Set manhole base so that a maximum grade adjustment of eight (8) inches is required to bring the manhole frame and cover to final grade.

Use precast concrete grade rings to adjust manhole frame and cover to final grade.
 - 3. Set precast concrete barrel sections plumb with a 1/4-inch maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber "O" ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with non-shrink grout to the satisfaction of the Engineer and the City.
 - 4. Allow joints to set for 14 hours before backfilling unless a shorter period is specifically approved by the Engineer or the City.
 - 5. Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.
 - 6. Core holes in precast sections to accommodate pipes prior to setting manhole sections in place to prevent jarring which may loosen the mortar joints.
 - 7. Backfill carefully and evenly around manhole sections.
- B. Manhole Pipe Connections
 - 1. Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.

C. Setting Manhole Frame and Cover

1. Set manhole covers and frames in a full mortar bed. Utilize precast concrete grade rings, for a maximum adjustment of twelve (12) inches, to assure frame and cover are set to the finished grade. Set manhole frame and cover to final grade prior to placement of permanent paving.

WW1.11 TESTS

- A. Test each manhole in accordance with Section CIP12- TESTING OF PIPELINES AND MANHOLES. Engineer or the City's representative shall observe each test.

WW1.12 CLEANING

- A. Thoroughly clean all new manholes of all silt, debris and foreign matter of any kind, prior to final inspections.

WW1.13 PAYMENT

- A. Payment for furnished and installed manholes shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the reinforced concrete pipe including but not limited to excavation, bedding, backfill, connection to pipe, etc. shall be subsidiary to this item.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION WW2 – POLYVINYL CHLORIDE (PVC) PIPE-WASTEWATER

WW2.01 SCOPE OF WORK

- A. This specification covers the requirements to install and test polyvinyl chloride (PVC) pipe and fittings, including excavation, sheeting, storing, dewatering, pipe laying, jointing, testing, backfilling, and any other work that is required or necessary to complete the installation as shown in the Plans as specified herein, complete as shown on the Plans and as specified herein.

WW2.02 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the names of the pipe and fittings suppliers, a list of materials to be furnished, shop drawings on required pipes and fittings, certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM Standards specified herein, and all other pertinent data to illustrate conformance to the specification found within.

WW2.03 QUALITY ASSURANCE

- A. All PVC pipe and fittings shall be from a single Manufacturer. The Supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contract, plus the cost of inspection of disapproved pipe, will be borne by the Contractor.
- B. Inspections of the pipe may also be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

WW2.04 POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

- A. Pipe and fittings shall be Type PSM, PVC SDR 26 with full diameter dimensions and shall conform to ASTM D3034, or Type PS-46 PVC conforming to ASTM F789, for sizes 4 through 15-inch and shall conform to ASTM F679 for sizes 18 through 27-inch. Straight pipe shall be furnished in lengths of not more than 13-feet and wyes shall be furnished in lengths of not more than three (3) feet. Saddle wyes will not be allowed.
- B. PVC pipe and fittings shall have bell and spigot push-on joints. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM F477.
- C. All fittings and accessories shall have bell and/or spigot configurations compatible with the pipe.
- D. For Force Main, all pipe shall be C-900, DR-18 pipe or epoxy coated ductile iron encased with brown 8 mil. polyethylene film.

WW2.05 HANDLING AND CUTTING PIPE

- A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction.

- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. All pipe ends shall be square after cutting.
- D. While stored, pipe shall be adequately supported from below at not more than three (3) foot intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

WW2.06

JOINTING POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

- A. PVC wastewater pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.
- B. All manhole connections shall be as shown on the Plans.

WW2.07

INSTALLING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than $\frac{1}{16}$ -inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.
- B. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.
- C. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.
- D. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means.
- E. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell. Blocking under the pipe will not be permitted. The bedding as shown in the details of the Plans, shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. The bedding shall then be placed to 12-inches above the top of the pipe. The initial three (3) feet of backfill above the bedding backfill shall be placed in eight (8) inch layers and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial three (3) feet of backfill shall be approved by the pipe Manufacturer's representative prior to use.
- F. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.

- G. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- H. Precautions shall be taken to prevent flotation of the pipe in the trench.
- I. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened material shall be placed to fill any voids created and the screened material and backfill shall be re-compacted to provide uniform side support for the pipe.
- J. Pipe stubs for manhole connections shall not exceed 3.25-feet in length unless directed otherwise by the Engineer or the City. Install caps where required. When connecting to an existing manhole, the opening for the connection of the wastewater pipe and the manhole shall be cored using an approved coring machine to the dimensions and size required to install the flexible "SEAL BOOT" resilient connector that meets the requirements of ASTM C-923. The connection shall be watertight when complete and meet the requirements of Section WW1- CONCRETE MANHOLES.
- K. Wastewater mains shall be installed in straight trenches from manhole to manhole or manhole to cleanout. There will be no curvilinear installations of wastewater mains.

WW2.08 TESTING

- A. Testing and cleaning of pipe shall be as specified in Specification Section CIP12- TESTING OF PIPELINES AND MANHOLES.

WW2.09 PAYMENT

- A. The wastewater line, complete in place, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all manholes and no deduction in length will be made for such appurtenances. Installation of the wastewater line will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, testing equipment and incidentals and performing all work that is necessary for the installation of the pipe, fittings, embedment or encasement, and all other appurtenances in accordance with the Plans and the provisions of these specifications.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION WW3 – CONNECTIONS TO AND WORK ON THE EXISTING WASTEWATER SYSTEM

WW3.01 SCOPE OF WORK

- A. This specification covers the requirements to maintain flow in existing sewers, handle existing wastewater flow, construct and maintain all temporary connections and diversions and construct the permanent connections to the new system as shown on the Plans and as directed by the Engineer.

WW3.02 SUBMITTALS

- A. None required unless specifically called for in the Plans, details, or requested by the Engineer.

WW3.03 GENERAL

- A. The Contractor shall supply all materials, equipment and labor required for plugging existing wastewater lines, all work on existing manholes (including all work and materials required to reshape existing manhole inverts with concrete and connecting new wastewater lines to existing manholes) and all additional work required.
- B. Should damage of any kind occur to the existing wastewater line, the Contractor shall at his/her own expense, as part of the work under this Section, make repairs to the satisfaction of the Engineer.
- C. The Contractor shall notify the Engineer immediately of any discrepancies in elevations of existing wastewater lines and manholes between those shown on the Plans and those established during construction in order that the Engineer can make the necessary modifications.
- D. All new wastewater pipe for connection shall conform to the pipe specifications in Section WW2- POLYVINYL CHLORIDE (PVC) PIPE - WASTEWATER.

WW3.04 HANDLING WASTEWATER FLOWS

- A. The Contractor shall provide all labor, equipment and materials necessary to maintain existing flows, including temporary diversions and all pumping of sewage that may be required to prevent backing up of wastewater lines and shall immediately remove all offensive matter at his/her own expense.
- B. The Contractor shall not be permitted to overflow, bypass, pump or by any other means convey sewage to any stream, or other water course.
- C. All procedures for maintaining flows must meet the approval of the Engineer and the Contractor shall be required to submit to the Engineer, for approval, a detailed written plan of all methods of flow maintenance 10 days in advance of flow interruption.

WW3.05 PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION W1 – DUCTILE IRON PIPE AND FITTINGS

W1.01 SCOPE OF WORK

- A. This specification covers the requirements to furnish and install ductile iron pipe and ductile iron pipe fittings including bracing, pipe laying, jointing, testing, blocking, and any other work that is required or necessary to complete the installation as shown on the Plans and as specified herein.

W1.02 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature including the name of the pipe and fitting suppliers and a list of materials to be furnished, completely detailed working drawings and schedules of all ductile-iron pipe and fittings required, prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified herein.

W1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength.
- B. American Water Works Association (AWWA)
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pressure Pipe and Fittings.
 2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
 3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-in for Water and Other Liquids.
 4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. AWWA C115 - Standard for Flanged Ductile-Iron Pipe with Threaded Flanges.
 6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 7. AWWA C153 - Ductile-Iron Compact Fittings, 3-inch Through 16-inch for Water and Other Liquids.
 8. AWWA C600 - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
 9. AWWA C651 - Disinfection Water Mains
- C. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

W1.04 QUALITY ASSURANCE



- A. All pipe shall be from one single source and all fittings shall be from one single source. All ductile-iron pipe to be installed under this Contract may be inspected at the foundry for compliance with these Specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of inspection of disapproved pipe will be borne by the Contractor.
- B. Inspection of the pipe will be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

W1.05

MATERIALS

- A. Ductile iron pipe shall conform to AWWA C151, be manufactured from metal having a minimum tensile strength of 60,000 psi, a minimum yield strength of 42,000 psi, and a minimum elongation of 10 percent (60-42-10), and be provided in the following minimum pressure classes:
 - 1. 12-inch and smaller, Class 350.
 - 2. 14-inch through 20-inch, Class 250.
 - 3. 24-inch, Class 200.
 - 4. 30-inch and larger, Class 150.
- B. Ductile iron fittings shall conform to AWWA C110 or C153.
- C. All pipe and fittings shall have a bituminous outside coating in accordance with AWWA C151 and C110, respectively. All pipe and fittings shall be cement-mortar lined and seal coated in accordance with AWWA C104. Cement mortar lining shall be double thickness.
- D. Ductile iron pipe with push-on or mechanical joints shall be centrifugally cast pipe in accordance with AWWA C150 and C151.
- E. Restrained joints shall be restrained push-on joints, TR Flex by U.S. Pipe and Foundry; Flex-Ring, or equal. Joints shall be suitable for 250 psi working pressure and be fabricated of heavy section ductile iron casting. Bolts and nuts shall be low carbon steel conforming to ASTM A307, Grade B.
- F. Sleeve type couplings shall be of steel and shall be Style 38 by Dresser Manufacturing Division, Smith-Blair or equal. Couplings shall be furnished with black steel bolts and nuts and with pipe stop removed. Gaskets shall be of a material suitable for exposure to liquid within the pipe.



W1.06

POLYETHYLENE ENCASEMENT

- A. All buried ductile iron pipe and metallic fittings shall be encased with 8 mil, Type I, Grade E-1, polyethylene film conforming to AWWA C105. Class usage shall be:
 - 1. Class A - Natural Color where exposure to weather (including sunlight) is less than 48 hours total before burial.
 - 2. Class C - Black where exposure to weather (including sunlight) may be more than 48 hours.
- B. Exposure to weather shall be kept to a minimum, and in no case shall it exceed 10 days. The Class of polyethylene used shall be approved by the Engineer.
- C. Polyethylene encasement shall not be paid for separately, but the cost there of shall be included in the appropriate item of the Proposal and Bid Schedule.

W1.07

LAYING DUCTILE IRON PIPE AND FITTINGS

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the Engineer. Handling and laying of pipe and fittings shall be in accordance with the Manufacturer's instruction and as specified herein.
- B. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when laid, shall conform to the lines and grades required. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Ductile iron pipe and fittings shall be installed in accordance with the requirements of AWWA C600 except as otherwise provided herein. All piping on this project regardless of size or class shall be placed in the embedment as shown on the detail sheets in the Plans. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.
- C. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the Manufacturer. Fittings, in addition to those shown on the Plans, shall be provided, if required, for crossing utilities which may be encountered upon opening the trench. Solid sleeves shall be used only where approved by the Engineer and the City.
- D. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be joined with a bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.
- E. Joints shall be protected by eight (8) mil. Polyethylene film prior to placing concrete. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint.

W1.08

PUSH-ON JOINTS

- A. Push-on joints shall be made in accordance with AWWA C111 and the Manufacturer's instructions. Pipe shall be laid with bell ends in the direction of trenching. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be laid shall then be aligned and inserted in the bell of the pipe to which it is to be joined and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

W1.09

MECHANICAL JOINTS

- A. Mechanical joints shall be made in accordance with Appendix "A" of AWWA C111 and the Manufacturer's instructions. Thoroughly clean and lubricate the joint surfaces and rubber gasket with soapy water before assembly. Bolts shall be tightened to the specified torque. Under no conditions shall extension wrenches or pipe over the handle of ordinary ratchet wrench be used to secure greater leverage.

W1.10

RESTRAINED JOINTS

- A. Restrained joints shall be installed where shown on the Plans. The joint assemblies shall be made in accordance with the Manufacturer's recommendations.

W1.11

SLEEVE TYPE COUPLINGS

- A. Couplings shall be installed where shown on the Plans. Couplings shall not be assembled until adjoining push-on joints have been assembled. After installation, apply a heavy bitumastic coating to bolts and nuts.

W1.12

POLYETHYLENE ENCASUREMENT

- A. The polyethylene encasement shall be installed in accordance with either method specified in AWWA C105.

W1.13

CONCRETE AND BLOCKING

- A. 2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline, in such manner as will substantially brace the pipe against undisturbed trench walls. Concrete blocking, made from Type I cement, shall have been in place four (4) days prior to testing the pipeline as hereinafter specified. Test may be made in two (2) days after completion of blocking if Type III cement is used.
- B. At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.
- C. Concrete blocking will not be measured or paid for as a separate item but the cost thereof shall be included in the proper items listed in the Proposal and Bid Schedule.

W1.14

CLEANING

- A. At the conclusion of the work thoroughly clean all of the new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If obstructions remain after this cleaning, the obstructions shall be removed.

W1.15

CONNECTIONS AND APPURTENANCES

- A. The Contractor shall make the alterations and the necessary connections to existing water mains as shown on the Plans. Such connection shall be made at such time and in a manner approved by the City; in each case, when the work is started, it shall be prosecuted expeditiously and continuously until completed.
- B. Fittings, bends, plugs and valves and shall be of standard manufacture and mechanical joint type to fit AWWA pipe specifications in Classes A, B, C and D, unless otherwise shown on the Plans.
- C. Payment for fittings and gate valves shall be restrained and shall be made separately under the appropriate bid items listed in the Proposal and Bid Schedule.

W1.16

LEAKAGE TESTING AND STERILIZATION

- A. All Ductile Iron Pipe shall be leak tested and sterilized according to Section CIP12 – TESTING OF PIPELINES.

W1.17

PAYMENT

- A. The pipeline, complete in place, including cleanup, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all fittings, specials, valves, etc., and no deduction in length shall be made for such appurtenances. Installation of the pipeline will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals and performing all work that is necessary for the installation, testing, and sterilization of the pipe, fittings, connections, blocking, embedment or placing in encasement pipe and all other appurtenances in accordance with the Plans and the provisions of the Specifications.

END OF SECTION

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TECHNICAL SPECIFICATIONS

SECTION W2 – POLYVINYL CHLORIDE (PVC) PIPE-WATER

W2.01 SCOPE OF WORK

- A. This specification covers the requirements to install polyvinyl chloride (PVC) water pipe and ductile iron fittings for the water line, including excavation, sheeting, shoring, dewatering, pipe laying, jointing, testing, backfilling and any other work that is required or necessary to complete the installation as shown on the Plans and as specified herein.

W2.02 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the name of the pipe and fittings suppliers, a list of materials to be furnished, shop drawings and schedules of all PVC pipe and fittings required, prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was Manufactured and tested in accordance with the ASTM Standards specified herein.

W2.03 QUALITY ASSURANCE

- A. All PVC pipe and fittings shall be from a single Manufacturer. The supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 and/or ASTM F758 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contract, plus the cost of inspection of disapproved pipe, will be borne by the Contractor.
- B. Inspections of the pipe may also be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

W2.04 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Polyvinyl chloride pipe for water lines, unless otherwise specifically shown on the Plans, or approved in writing, shall be AWWA C900 or C909 Class 150 psi with a dimension ratio of 18 (DR-18), for water lines and shall be extruded, be of rubber gasket type, and be furnished in 20-foot nominal laying lengths. All such pipe shall bear a mark denoting approval by the Underwriters' Laboratories of Chicago, Illinois, so that it will be acceptable to the Texas State Fire Insurance Commission for use in fire protection lines without penalty. All joints shall be of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Each size of polyvinyl chloride pipe shall have the same outside diameter as the corresponding size of cast iron pipe.
- B. Fittings shall be ductile iron, mechanical joint or flanged type and shall be Class 250 in accordance with AWWA Specifications C110-77, C-111-80, and C115-75. Flanges shall be faced and drilled in accordance with ASA Standard B16.1, Class 125 unless otherwise shown on the Plans or in the Special Conditions. All fittings shall be tar coated on the outside surface and shall have an interior cement lining with seal coat per AWWA Specifications C104-80 unless otherwise shown or specified.
- C. The Contractor shall obtain installation instructions, including support spacing and solvent welding, from the supplying Manufacturer, shall comply with the instructions, and shall meet the requirements of ASTM D-2855, Standard Recommended Practice for making Solvent Cemented Joints with PVC Pipe and Fittings. The PVC solvent cement shall comply with ASTM D-2564 and shall be furnished by the pipe and fitting Manufacturer for the class and type of pipe supplied to the project.

W2.05 HANDLING AND CUTTING PIPE

- A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction.
- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. All pipe ends shall be square after cutting.
- D. While stored, pipe shall be adequately supported from below at not more than three (3) foot intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

W2.06

JOINTING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. PVC pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.

W2.07

INSTALLING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Unless otherwise specified on the Plans, polyvinyl chloride pipe shall be installed to clear all utility lines and shall have three (3) feet minimum cover. For water lines to be constructed under a future roadway, the cover may be increased to allow for future paving grades. The depth of cover, where shown on the Plans, is that distance from the top of the pipe to the approximate proposed grade line.
- B. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than $\frac{1}{16}$ -inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.
- C. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.
- D. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.
- E. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying.
- F. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, embedment material shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Embedment material shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the embedment material under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Embedment material shall then be placed to 12-inches above the top of the pipe. Next, the varying depths of select material backfill above the embedment material backfill shall be placed according to the Plan Details and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient select material backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in

compacting the varying depths of select material backfill shall be approved by the pipe Manufacturer's representative prior to use. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell.

- G. Perforated PVC Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM F758 and as specified herein. As soon as the excavation for the trench is complete to normal grade of the bottom of the trench, geotextile fabric shall be laid and then the pea gravel bedding shall be carefully placed (so not to damage the geotextile fabric) and graded to provide uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. Before the perforated pipe is laid on the trench, the perforated pipe shall be wrapped around and closed according to the Manufacturer's closure recommendations with the geotextile fabric. The pipe shall be laid accurately to the lines and grades indicated on the Plans. Blocking under the perforated PVC pipe will not be permitted. Pea gravel shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to gently place the pea gravel under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Making sure not to damage the geotextile fabric, pea gravel shall then be carefully placed above the top of the perforated pipe varying from two to three (2-3) feet depending on the Plans. Once the remaining pea gravel has been placed, overlap or close the geotextile fabric according to the Manufacturer's recommendations or six (6) inches minimum overlap. Then one (1) foot of topsoil shall be placed over the pea gravel to the ground level with proper grass sodding on top.
- H. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.
- I. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- J. Precautions shall be taken to prevent flotation of the pipe in the trench.
- K. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and backfill or embedment material. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, embedment material shall be placed to fill any voids created and the embedment material and backfill shall be recompacted to provide uniform side support for the pipe.

W2.08

CONCRETE AND BLOCKING

- A. 2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline, as shown in the Standard Details and in such manner as will substantially brace the pipe against undisturbed trench walls. In no event shall this quantity of concrete blocking be less than those shown in the Plans. Concrete blocking, made from Type I cement, shall have been in place four (4) days prior to testing the pipeline as hereinafter specified. Tests may be made in two (2) days after completion of blocking if Type III cement is used.
- B. At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.
- C. Concrete blocking will not be measured or paid for as a separate item but the cost thereof shall be included in the various items listed in the Proposal and Bid Schedule.

W2.09

TESTING AND ALLOWABLE LEAKAGE

- A. All PVC pipe and fittings shall be leak tested and sterilized according to Section CIP12.05- TEST PROCEDURES FOR PRESSURE PIPELINES.

W2.10

PAYMENT

- A. The pipeline, complete in place, including cleanup, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all fittings, specials, valves, etc., and no deduction in length shall be made for such appurtenances. Installation of the pipeline will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals and performing all work that is necessary for the installation, testing, and sterilization of the pipe, fittings, connections, blocking, embedment or placing in encasement pipe and all other appurtenances in accordance with the Plans and the provisions of the Specifications.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION W3 – VALVES, HYDRANTS AND APPURTENANCES

W3.01 SCOPE OF WORK

- A. This specification covers the requirements to provide all buried valves, valves in manholes and underground vaults, hydrants and appurtenances complete with actuators and all accessories as shown on the Plans and as specified herein.

W3.02 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including Manufacturer's literature, illustrations, specifications and engineering data which includes dimensions, size, materials of construction, weight, protection coating, and all other pertinent data to illustrate conformance to the specification found within. The Contractor shall also submit four (4) copies of all certified shop test results specified herein, complete operation and maintenance manuals including all copies of all approved shop drawings, and certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests, and certification of proper installation.

W3.03 REFERENCE STANDARDS

- A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. American Water Works Association (AWWA)
1. AWWA C515 - Gate Valves, three (3)-inch through 48-inch NPS, for Water and Sewage Systems.
 2. AWWA C502 - Dry-Barrel Fire Hydrants.
 3. AWWA C509 - Resilient-Seated Gate Valves, three (3) inch through 12-inch NPS, for Water and Sewage Systems.
- C. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
 2. ANSI C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- D. American Society for Testing and Materials (ASTM)
1. ASTM A48 - Gray Iron Castings.
 2. ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings
 3. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 4. ASTM A276 - Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes.
 5. ASTM A536 - Ductile Iron Castings.
- E. Steel Structures Painting Council (SSPC)

1. SSPC SP-6 - Commercial Blast Cleaning
- F. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

W3.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site to ensure uninterrupted progress of the work.
- B. Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.
- C. Provide covers for all openings.
 1. All valves three (3) inches and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
 2. All valves smaller than three (3) inches shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.
- D. Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of City acceptance shall be removed, or the valve shall be removed from the job.
- E. Store all equipment in covered storage off the ground.

W3.05 COORDINATION

- A. Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation and site utilities.
- B. Contractor shall coordinate the location and placement of concrete thrust blocks when required.

W3.06 GENERAL

- A. All valves shall open counter-clockwise.
- B. The use of a Manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C. Valves shall be of the size shown on the Plans or as noted, and as far as possible equipment of the same type shall be identical and from one Manufacturer.
- D. Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.
- E. Unless otherwise noted, valves shall have a minimum working pressure of 200 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.
- F. Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.
- G. Valves shall be constructed for buried service.

W3.07 VALVE BOXES

- A. All gate valves shall be provided with extension shafts (where the operating nut is greater than five (5) feet below grade), operating nuts and valve boxes as follows:
1. Extension shafts shall be steel and the operating nut shall be two (2) inches square. Shafts shall be designed to provide a factor of safety of not less than four (4). Operating nuts shall be pinned to the shafts.
 2. Valve boxes shall be a heavy-pattern cast iron, three (3) piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 5¼-inches. Barrel length shall be adapted to the depth of cover, with a lap of at least six (6) inches when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow and "WATER" shall be cast in the cover when used on a water line or "SEWER" when used on a wastewater force main. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box. The valve box lid shall be furnished with a pentagon-head bolt for locking.
 3. The upper section of each box shall have a bottom flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
 4. An approved operating key or wrench shall be provided.
 5. All fasteners shall be Type 304 stainless steel.

W3.08

RESILIENT SEATED GATE VALVES

- A. Valves shall be manufactured in accordance with AWWA C509.
- Acceptable Gate Valves are:
1. American Flow Control – Series 2500
 2. Mueller – 2360 Series
 3. Clow
- B. Valves shall be provided with a minimum of two (2) O-ring stem seals.
- C. Bonnet and gland bolts and nuts shall be either fabricated from a low alloy-steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.
- D. Wedges shall be totally encapsulated with rubber.
- E. Units shall be, in addition, UL and FM approved.
- F. Resilient wedge gate valves shall be furnished and installed in sizes and shall be manufactured in accordance with the latest AWWA C-509 and cast iron shall conform to the latest ASTM A-126 standards. Gate valves furnished under these specifications shall be of the solid wedge, resilient seat type with cast iron/ductile iron body and bronze stem designed for 250 pounds per square inch working pressure. All gate valves shall be tested hydrostatically to 400 pounds per square inch. Gate valves shall meet the latest AWWA standard specifications (C-509).
- G. The seat shall be made of Styrene Butadiene rubber and provide a positive water tight seal. The seat shall be permanently bonded or mechanically attached to the wedge with stainless steel screws. If bonded, ASTM P-429 requirements shall be followed. Non-rising stem gate valves shall be equipped with "O" ring type packing gland consisting of at least two (2) "O" rings. The thrust collar shall work in an "O" ring seal lubricant reservoir or against bearings or washers, above and below constructed of Delrin or approved equal material. Gate valve stems, shall be fabricated from solid bronze rod having a tensile strength of not less than 60,000 pounds per square inch, and a minimum yield strength of 30,000 pounds per square inch.

- H. Cast iron body shall be of iron with an even grain and shall possess a tensile strength of not less than 32,000 pounds per square inch. All bronze castings, except the stem, shall have a tensile strength of not less than 30,000 pounds per square inch. The entire internal valve body surfaces shall be coated with a factory applied two (2) component epoxy system or approved equal. The seating surface shall be machined or otherwise constructed to provide a smooth, even surface for the resilient seat. All valves shall open left (counter clockwise) and have a two (2) inch square wrench nut unless specified otherwise.

W3.09

TAPPING SLEEVES AND TAPPING VALVES

- A. Tapping sleeves shall be of cast iron epoxy coated, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe, Mueller, Clow, or equal. Nuts and bolts shall be Type 304 stainless steel.
- B. Size-on-Size tapping sleeve shall be ductile iron or cast iron.
- C. Tapping valves shall conform to the requirements specified above for gate valves except that one (1) end shall be flanged and one (1) mechanical. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters. Tapping valves shall be Ford B81-777 or equal.

W3.10

CHECK VALVES

- A. Controlled Closing Swing Check Valves (lever & weight)
 - 1. Check valves shall be of the controlled closing swing type. The controlled closing swing check valves shall be guaranteed to operate under severe conditions as check valves. The valve shall be designed to open smoothly, provide full pipe line flow, permit minimum head loss and close at a controlled rate of speed for the final predetermined portion of its stroke. All bolts and nuts used in the assembly shall be steel, commercial.
 - 2. The valve body shall be Cast Iron ASTM A126-B/ductile iron ASTM A536. The disc arm and chamber level shall be of heavy steel construction and keyed to the hinge shaft. The hinge shaft shall be of 18-8 stainless steel and of adequate diameter to withstand a complete hydraulic unbalance pressure of 125 psi on the valve disc. A single cushioning device mounted on the external side of the valve shall control the valve closure by way of the interchange of oil to and from an oil reservoir. The use of air or gas pressurized oil reservoir shall not be permitted. The oil plunger assembly shall be rigidly attached to the valve body by shoulder bolts or dowel pins to prevent fretting.
 - 3. The Manufacturer, if required by the Engineer or the City, shall submit design calculations of principle component stresses to substantiate the integrity of the valve for the working pressure involved.
 - 4. The valve when closed shall be tight seating by way of a resilient replaceable seat against a bronze seat ring in the body.

5. Valves shall be as manufactured by GA Industries or Series 6000 as manufactured by APCO. The City reserves the right to inspect all valves before shipment is made. Any failure of valves to operate satisfactorily during the first year of installation due to faulty workmanship or defective material shall be replaced and made good by the Manufacturer. Under these specifications, any valve stuffing box that leaks for any reason or because of excessive wear or deterioration of packing, shall be reason for classification as defective material.

B. Slanted / Tilted Check Valves

1. Slanted or tilted check valves shall be furnished and installed where shown on the Plans.
2. The body of the valve shall be ductile iron or cast iron with access ports to the disc. The disc shall be cast iron. The seat and disc rings shall be bronze. Pivot pins and bushings shall be bronze or stainless steel. The valve shall include a localized indicator of the position of the valve.
3. The valves shall include a top mounted oil dash pot to prevent slamming of the disc. The dash pot shall control the last 10% of closure of the disc. The speed of closure within this 10% shall be adjustable.
4. Valves shall be APCO Slanting Disc, Valmatic or Golden Anderson Tilted Disc or approved equal.

W3.11 FLANGES

- A. Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Dimensions and drilling of flanges shall be in accordance with the American Standard Association for a working pressure of 125 pounds per square inch. Special drilling shall be provided where necessary.

W3.12 FIRE HYDRANTS

- A. Fire hydrants shall be dry-barrel type conforming to the requirements of the latest revision of AWWA C502. Hydrants shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.
- B. Hydrants shall have six (6)-inch mechanical joint inlet connections, two 2½-inch hose connections and one 4½-inch pumper connection. Threads for the hose and pumper connections shall be in accordance with National Standard Thread. Hydrants shall be according to Manufacturer's standard pattern. Hydrants shall be equipped with "O" ring packing. Each nozzle cap shall be provided with a Buna-N rubber washer.
- C. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism or obstructing the discharge from any outlet. The body of the hydrant shall be equipped with a breakable flange, or breakable cast iron flange bolts, just above the grade line.
- D. A bronze or rustproof steel nut and check nut shall be provided to hold the main hydrant valve on its stem.
- E. Hydrant valve opening shall have an area at least equal to that area of a 4½-inch minimum diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons minimum through its two 2½-inch hose nozzles when opened together with a loss of not more than two (2) psi in the hydrant.
- F. Hydrants shall be designed for installation in a trench that will provide minimum cover as noted on Plans and for the flange to be 3 ½-inches above ground surface. Hydrant extensions shall be as manufactured by the company furnishing the hydrants and of a style appropriate for the hydrants as furnished.
- G. Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so

as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs or gravity is not acceptable.

- H. Operating stems whose threads are located in the barrel or waterway shall be of manganese bronze, everdur, or other high-quality non-corrodible metal, and all working parts in the waterway shall be bronze to bronze.
- I. Hydrants shall open by turning operating nut to left (counter-clockwise) and shall be marked with a raised arrow and the word "open" to indicate the direction to turn stem to open hydrant.
- J. Hydrants shall be furnished with caps, double galvanized steel hose cap chain, galvanized steel pumper hose cap chain, a galvanized steel chain holder and any other hooks and/or appurtenances required for proper use.
- K. Hydrant operating nut shall be AWWA Standard pentagonal type measuring 1½-inch point to flat.
- L. Hydrants shall be hydrostatically tested as specified in AWWA C502.
- M. Hydrants shall be of the following:
 - 1. Kennedy – K81
 - 3. American Darling – B84B
 - 2. Clow Medallion
- N. All iron work to be set below ground, after being thoroughly cleaned, shall be painted with two (2) coats of asphalt varnish specified in AWWA C502. Iron work to be left above ground shall be factory primed and painted silver using a high grade enamel paint of quality and color to correspond to the present standard of the City.
- O. Fire hydrants shall be installed on the same side of the street or roadway as the water main and shall be installed plumb and true.
- P. Heel and thrust blocks shall be placed in undisturbed soil as shown in the details of the Plans.
- Q. Double blue reflector “HYE – LITES” brand as manufactured by pavement markers ink shall be installed at the centerline of the street or roadway perpendicular to the hydrant.

W3.13 CORPORATION STOPS

- A. Corporation stops shall be brass, not less than 1-inch in diameter and shall be installed where shown, specified or required.
- B. Provide corporation stops as manufactured by the following:
 - 1. Ford Company

W3.14 COMBINATION AIR-VACUUM RELIEF VALVES

- A. The air-vacuum release valves shall be installed as shown on the Plans. The valve body shall be of cast iron ASTM A126-B; the floats, float guide, and stem shall be of Type 316 stainless steel. The resilient seat shall be of Buna N. The valve shall be suitable for 150 psig working pressure. Valve shall have standard NPT inlets and outlet ports with diameters as indicated on the Plans. Valve shall be Model 200A Series by APCO Valve and Primer Corporation, Schaumburg, IL, or approved equal.

W3.15 SURFACE PREPARATION AND SHOP COATINGS

- A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-6 and painted with two (2) coats of an approved two (2) component coal tar

epoxy coating specifically formulated for potable water use. The coating used must appear on the current edition of the United States Environmental Protection Agency's list entitled "Accepted Categories and Subcategories of Coatings, Liners and Paints for Potable Water Usage."

- B. Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6 and given two (2) shop coats of a heavy coat tar enamel or an approved two (2) component coat tar epoxy paint.

W3.16 INSPECTION AND PREPARATION

- A. During installation of all valves and appurtenances, the Contractor shall verify that all items are clean, free of defects in material and workmanship and function properly.
- B. All valves shall be closed and kept closed until otherwise directed by the Engineer or the City.

W3.17 INSTALLATION OF BURIED VALVES AND VALVE BOXES

- A. Buried valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve.
- B. Before backfilling, all exposed portions of any bolts shall be coated with two (2) coats of bituminous paint.

W3.18 INSTALLATION OF TAPPING SLEEVES AND VALVES

- A. The City of Georgetown shall be contacted and their permission granted prior to tapping a line. The required procedures and time table shall be followed exactly.
- B. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be a minimum of 1/4-inch less than the inside diameter of the branch line.
- C. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor.
- D. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three (3) feet from a pipe joint.
- E. A tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the Engineer and the City shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.
- F. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

W3.19 INSTALLATION OF FIRE HYDRANTS

- A. Fire hydrants shall be set at the locations as shown on the Plans and bedded on a firm foundation. Hydrants and connecting pipe shall have at least the same depth of cover as the distributing pipe. A drainage pit as detailed on the Plans shall be filled with 3/4-inch washed rock gravel and compacted. The hydrants shall be set upon a slab of concrete not less than four (4)-inches thick and 15-inches square. During backfilling, additional screened gravel shall be brought up around and six (6) inches over the drain port. Each hydrant shall be set in true vertical alignment and properly braced.

- B. 2,500 psi concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Plans. Eight (8) mil. Polyethylene film shall be placed around the hydrant elbow before placing concrete. CARE SHALL BE TAKEN TO ENSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS.
- C. All connections from the main to the fire hydrants shall be anchoring mechanical joints designed to prevent movement due to thrust or pressure.
- D. The hydrant shall be tied to the pipe with suitable rods or clamps, and shall be coated with Koppers 300 or approved equal at a minimum of 8 mil. thick. Bolts shall have a zinc bolt cover per AWWA. Hydrant paint shall be touched up as required after installation.
- E. Fire hydrants shall be factory primed and painted silver using a high grade enamel.
- F. Fire sprinkler lines shall be protected by a reduced pressure zone (RPZ). All fire lines shall be ductile iron pipe. All private fire lines shall be separated by double detecta check.

W3.20

FIELD TESTS AND ADJUSTMENTS

- A. Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of Engineer or the Representative of the City to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided by the Contractor at his/her sole expense.

W3.21

PAYMENT

- A. Gate valves, tapping sleeves and tapping valves, fire hydrants, and air and vacuum relief valves complete in place as shown on the Plans and as specified, will be paid for at the unit contract price per each as provided in the Proposal and Bid Schedule.
- B. The unit price per each installation shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work including excavation, base blocking, disposal of surplus materials and backfill in conformance with the Plans and these specifications. The six (6) inch connection pipe, six (6) inch gate valve, test station, concrete collar, thrust block, drain pit, concrete pad, rods, bolts, paint, protective coatings, and fittings for fire hydrants shall not be paid for separately.
- C. Fire hydrants shall be furnished with the proper length of barrel to comply with these specifications. Barrel extensions will not be measured and paid for separately.
- D. No separate payment shall be made for work performed in accordance with this specification, other than that listed in Parts A-C of this subsection, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION W4 – ENCASEMENT PIPE

W4.01 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing encasement pipe complete in place including any required spacers and end plugs as shown on the plans and specified herein.

W4.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature including type and Manufacturer of pipe, spacers, and end plugs, and all other pertinent data to illustrate conformance to the specification found within.

W4.03 GENERAL

- A. Where pipe is required to be installed under highways, streets, or other facilities, construction shall be made in such a manner that will not interfere with the operation of the street, highway, or other facility, and shall not weaken or damage any embankment or structure.
- B. All carrier pipe shall be laid to the required line and grade within the specified limits through the encasement pipe. Carrier pipe shall be handled and placed in the encasement pipe by use of proper skids, wedges, guide fails or other approved means. Care shall be taken that once the pipe is in place to line and grade, it shall not be disturbed or become displaced. All carrier pipe shall have restrained joints.

W4.04 MATERIALS

- A. Encasement pipe shall be smooth steel 35,000 psi yield strength with thickness according to the following table:

Carrier Size (Inner Diameter)	Minimum Encasement Steel Casing Size (Inner Diameter)	Minimum Casing Thickness (Inches)
4"	14"	0.2500
6"	16"	0.2500
8"	18"	0.2500
10"	20"	0.3125
12"	24"	0.3175
14"	24"	0.375
16"	30"	0.4375
18"	30"	0.4375
20"	36"	0.500
24"	42"	0.500
27"	42"	0.500
30"	48"	0.500
33"	48"	0.500
36"	54"	0.500
39"	60"	0.500
42"	60"	0.500

- B. Casing spacers shall be bolt-on style with a shell made in two (2) sections of Heavy T-304 stainless steel. Connecting flanges shall be ribbed for extra strength. Casing spacers shall have runners made of ultra high molecular weight polymer, with a minimum height of two (2) inches. Wedges shall not be used between the top of the carrier pipe and the inside of the encasement pipe. Casings spacers shall have a minimum of one (1) inch clear distance between the runners on top of the casing spacers and the inside of the encasement pipe. Prior to inserting the carrier pipe, all water shall be pumped out of the encasement pipe to at least a point where no more than two (2) inches of water remains. Spacers shall be required within at least three (3) feet from both openings of the encasement pipe and spaced no greater than six (6) feet through out the encasement pipe. Casing spacers will not be paid for directly but shall be considered subsidiary to the bid item of encasement pipe. . Casing spacers shall be made by Cascade Waterworks MFG Company or approve equal.
- C. End Plugs shall be provided as required and as specified by the pipe manufacturer.

W4.05

PAYMENT

- A. Separate payment will be made for Steel Encasement Pipe per linear foot as called for on the Plans and set forth in the Proposal and Bid Schedule.
- B. All costs incurred for furnishing and installing encasement pipe shall include all labor, materials, tools, equipment and incidentals necessary to perform all work or whatever nature required to complete the specific operation.

END OF SECTION

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Project information.
- 2. Specification and Drawing conventions.

- B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
- 2. Section 017300 "Execution" for coordination of Owner-installed products.

1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.4 PROJECT INFORMATION

- A. Project Identification: San Gabriel WWTP Rehabilitation Project:

- 1. Project Location: Georgetown, TX.



- B. Owner: City of Georgetown, Georgetown Municipal Complex, Purchasing Department, at 510 W. 9th Street, Georgetown, Texas 78626.

- C. Engineer: CDM Smith, Inc., 9430 Research Blvd., Suite 1-200, Austin, Texas 78759.

- D. Engineer's Consultants: Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:

- 1. Geotechnical Engineer: Terracon Consultants, Inc.:

- a. Project Engineer: Larson Snyder

- 1) Email: Larson.Synder@terracon.com

2) Phone: 512-891-2675

- E. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.5 WORK COVERED BY CONTRACT DOCUMENTS- NOT USED

1.6 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 - 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 - 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 011000

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SECTION 011716 - EXISTING UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes responsibilities for utility properties and service.
 - 1. Subsurface investigations performed by: Terracon Consulting indicating:
 - a. Subsurface conditions at various locations at the site.
 - b. Presented in Boring Logs.
 - 2. Existing ground profiles shown on the Plans: plotted from field surveys and existing Drawings.

1.3 CONTRACTOR ACKNOWLEDGEMENTS:

- A. Contractor is satisfied as to nature and location of the Work; general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; conformation and conditions of the ground; character of equipment and facilities needed preliminary to and during the prosecution of the Work; and all other matters which can in any way affect the Work or the cost thereof under this Contract.
- B. Contractor is further satisfied as to character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site, as well as from information presented herein as a part of these Contract Documents. Any failure to acquaint themselves with available information will not relieve Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the Work. Neither Owner nor Engineer assumes responsibility for any conclusion or interpretation made by Contractor on the basis of the information made available by Owner or Engineer.

1.4 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Known utilities and structures adjacent to or encountered in the Work are shown on Drawings. Locations shown are taken from existing records and the best information available from existing plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the

convenience of Contractor only, and no responsibility is assumed by either Owner or Engineer for their accuracy or completeness.

- B. Neither Owner nor his officers or agents shall be responsible to Contractor for damages as a result of Contractor's failure to protect utilities encountered in the Work.
- C. Provide unobstructed access to fire hydrants, underground conduit, manholes, and water or gas valve boxes at all times.
- D. Where Contractor's operations could cause damage which might result in considerable expense, loss, and inconvenience when operations are adjacent to or near railway, telegraph, telephone, television, power, oil, gas, water, sewer, irrigation, or other systems, do not commence operations until making all arrangements necessary for protection of these utilities and services.
- E. Notify utility offices that are affected by construction operation at least five days in advance of commencing construction operations. Do not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for existing underground utilities in advance of operations.
- F. Be solely and directly responsible to owners and operators of such utility properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage that may result from construction operations under this Contract.
- G. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, promptly notify proper authority and cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair. In no event shall interruption of any water or utility service be allowed unless prior approval is granted by utility owner.
- H. Replace other existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents.
- I. Where existing utility lines or structures are so located as to physically conflict with permanent structures to be constructed under this Contract, the conflicting utility line or structure shall be permanently relocated. Such relocations shall be considered as required by this Contract.
- J. Give immediate notice to Engineer, Owner and owner of the utility (where applicable) when a physical conflict is determined to exist. Any delays resulting from required relocations of utilities are the responsibility of Contractor.
- K. Where existing utility lines or structures are so located as to interfere with Contractor's prosecution of the Work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at expense of Contractor.
- L. Give immediate notice to Engineer and Owner of the utility when an interference is determined to exist and obtain approval to relocate such utility or to discontinue service from Engineer and utility owner. Utility owner shall have the right to do all work required to discontinue, relocate,

and replace interfering utilities and charge Contractor for related costs. When approved by Engineer and utility owner, work required to discontinue, relocate, and replace interfering utilities may be done by, or arranged for, by Contractor. All such discontinuance, relocation, and replacement shall be accomplished in accordance with all requirements of utility owner.

- M. When notified by Contractor that an interference or conflict has been determined to exist, Engineer will determine whether such interference shall be considered as required by construction or as incidental to construction.

1.5 INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage to existing structures whether on surface, aboveground, or underground. An attempt has been made to show major structures on Drawings. While information has been compiled from best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid known possible difficulties.
- B. Protect existing structures from damage, whether or not they lie within the right of way or the limits of the easements obtained by Owner. Where existing structures must be removed to properly conduct the Work, or are damaged during the Work, they shall be restored by Contractor's to at least their original condition and to satisfaction of Engineer.
- C. Contractor may, with approval of Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with Contractor's operations.

1.6 FIELD RELOCATION

- A. During the progress of the Work, minor relocations of the work may be necessary. Such relocations shall be made only by direction of Owner or Engineer. If existing structures are encountered that will prevent construction as shown, notify Owner or Engineer before continuing with the Work in order that Engineer may make such field revisions as necessary to avoid conflict with the existing structures. If Contractor fails to notify Owner or Engineer when an existing structure is encountered and proceeds with the Work despite this interference, Contractor shall be responsible for any damage that may occur.

1.7 LAND MONUMENTS

- A. Preserve or replace any existing Federal, State, County, City, and private land monuments encountered. All monument replacement by Contractor shall be performed by a land surveyor licensed in the State of Texas.

1.8 PAYMENT

- A. The Work specified in this Section shall be considered incidental and payment will be included as part of the appropriate lump sum or unit prices specified in the Section 00300, Proposal Form.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOTUSED)

END OF SECTION 011716

SECTION 012200 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the measurement and payment of the various elements of the Work; with provisions applicable to lump sum prices, unit prices, and Owner-Directed Improvements, if applicable.
- B. The Total Amount Proposed in the Proposal Form shall cover all Work required by the Contract Documents. The lump sum and unit prices proposed shall include all costs in connection with the proper and successful completion of the Work, including but not limited to: furnishing all materials, equipment, supplies, and appurtenances; providing all construction equipment and tools; and performing all necessary labor and supervision to fully complete the Work. All Work not specifically set forth as to the pay item or items in the Proposal shall be considered subsidiary obligations of Contractor and all costs in connection therewith shall be included in the prices or included in Proposal Item No. 2.
- C. Related Requirements:
 - 1. Section 00300 – Proposal Form
 - 2. Section 00700 – General Conditions
 - 3. Section 013300 – Submittal Procedures
 - 4. 014000 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROPOSAL FORM

- A. The Proposal Form is a part of these Contract Documents and lists each item of work for which payment will be made. No payment will be made for items other than those listed in the Pro-

posal Form. Lump Sum measurement will be for the entire item, unit of work, structure, or combination thereof, as specified and as indicated in the Proposal Form.

- B. Required items of work and incidentals necessary for the satisfactory completion of the Project which are not specifically listed in the Proposal Form, and which are not specified in this Section to be measured or to be included in one of the items listed in the Proposal Form shall be considered as incidental to the work required under this contract, and all costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the prices Proposal for the various Proposal Items. The Contractor shall prepare his Proposal accordingly.
- C. Work includes furnishing all plant, labor, equipment, tools and materials, and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.
- D. Measurement
 - 1. Measurement shall be based on the estimated percent complete of each item of the Schedule of Values, as determined by the Engineer.
- E. Payment
 - 1. Payment will be made at the lump sum price proportional to the completion percentages approved by the Engineer.

1.5 UNIT PRICE ITEMS

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

1.6 LUMP SUM ITEMS

- A. Lump Sum measurement will be for the entire item, unit of work, structure, or combination thereof, as specified and as indicated in the Proposal Form. Measurement and payment for all Proposal items indicated as Lump Sums shall include the cost of all labor, materials and equipment necessary to furnish, install, clean, test, and place each Proposal item into operation; including permitting, general conditions, overhead and profit.

- B. Progress payments will be based on schedule of values prepared by the Contractor and approved by the Engineer and Owner before acceptance of the first Application for Payment.
- C. In order for the Contractor to request progress payments against Lump Sum items, Contractor shall provide a disaggregation or breakdown in sufficient measurable detail that is acceptable to Engineer.
- D. Measurement
 - 1. Measurement shall be based on the estimated percent complete of each item of the Schedule of Values, as determined by the Engineer.
- E. Payment
 - 1. Payment will be made at the lump sum price proportional to the completion percentages approved by the Engineer.

1.7 OWNER-DIRECTED IMPROVEMENT

- A. Owner-Directed Improvements, if any, specified in the Contract Documents and indicated in the Proposal Form are considered provisional amounts to be used only if directed. Owner-Directed Improvements are exclusive of work indicated in the Contract Documents for which payment is included under other items in the Proposal Form. No work may be performed under an Owner-Directed Improvement without prior written approval of the Owner.
- B. Any unused balance of the Owner-Directed Improvements shall revert to the Owner upon completion of the project. Prior to final payment, the original amount provided for Owner-Directed Improvements shall be adjusted to actual costs by deductive Change Order, adjusting the contract price, accordingly.
- C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any unexpended portion of the Owner-Directed Improvements.
- D. The Contractor is to include time for Owner-Directed Improvement work in the construction schedule. No adjustment of Contract Time shall be allowed for any work performed under Owner-Directed Improvement items.
- E. Owner-Directed Improvement items shall be included in the Schedule of Values.
- F. Unless otherwise indicated in the specific measurement and payment provisions under Owner-Directed Improvement items, the measurable and allowable costs for work performed under an Owner-Directed Improvement item shall be limited to the actual, demonstrable, and direct costs associated with that Owner-Directed Improvement item. Shipping and sales taxes are allowable costs.
 - 1. No mark-up for overhead or profit shall be included for payment under an Owner-Directed Improvement account item. Overhead and profit shall be included in the contract base Proposal or allocated across other Proposal items.

2. Work authorized by the Owner under an Owner-Directed Improvement may be performed as a lump sum (negotiated before the fact), unit prices (when applicable), or time and material. For work performed under time and material, Contractor shall submit detailed verification (break-down) of all costs, subject to the approval of the Engineer or Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: Solids and Trash Removal, Loading, Transport, and Disposal from the Aeration Basins, Influent Lift Station Wet Well, Grit Basin, Clearwell, and Aerated Sludge Holding Tank.
 1. Description: Removal of approximately one-foot deep of grit, rags, and debris from the aeration basin, grit basin, irrigation water clearwell, and aerated sludge holding tank.
 2. Unit of Measurement: Wet Tons
 3. Review Specification Section 460200 "Tank and Structure Cleaning" for requirements.

END OF SECTION 012200

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form that is part of web-based Project management software and acceptable to Engineer.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 7 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. The Contractor shall note that the Engineer's design is based upon the first listed manufacturer for items of equipment, though not necessarily the manufacturer's "standard" product.
- B. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.
- C. If the Contractor chooses other manufacturer's equipment they shall be responsible for the total cost, including engineering design, of modifications, alterations, adjustment, and coordination necessary to make the proposed equipment compatible with the treatment process and with the specified equipment, structures, spaces and other features of the original design.

1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Engineer.
 - 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include

compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

- b. Requested substitution does not require extensive revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- d. Substitution request is fully documented and properly submitted.
- e. Requested substitution will not adversely affect Contractor's construction schedule.
- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
- g. Requested substitution is compatible with other portions of the Work.
- h. Requested substitution has been coordinated with other portions of the Work.
- i. Requested substitution provides specified warranty.
- j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012500

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Web-based Project management software package.
 - 6. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 2. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
 - 3. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

- A. RFI: Request for Information. Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and in prominent location in each administration facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and direction of Project coordinator to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Owner name.
 3. Owner's Project number.
 4. Name of Engineer.
 5. Engineer's Project number.
 6. Date.
 7. Name of Contractor.
 8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 00941 "Change Order Form and Instructions".
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 5 days of receipt of the RFI response.
- D. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. . Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Engineer.
 4. RFI description.
 5. Date the RFI was submitted.
 6. Date Engineer's response was received.
 7. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 8. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Engineer's Digital Data Files: Digital data files of Engineer's CAD drawings will be provided by Engineer for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Engineer.
 - a. Subcontractors, and other parties granted access by Contractor to Engineer's digital data files shall execute a data licensing agreement in the form of Agreement acceptable to Owner and Engineer.
- B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion. General Contractor shall be responsible for the full cost for the project team including costs for Owner, Engineer, Contractor, subcontractors and suppliers.

1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Engineer, Engineer's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 2. Provide up to seven Project management software user licenses for use of Owner, Engineer, and Engineer's consultants. Provide 4 hours of software training at Engineer's office for web-based Project software users.
 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Engineer. Provide data in locked format to prevent further changes.
 4. Provide one of the following Project management software packages under their current published licensing agreements:
 - a. Autodesk; Constructware.
 - b. Corecon Technologies, Inc.
 - c. Meridian Systems; Prolog.
 - d. Newforma, Inc.
 - e. Procore Technologies, Inc.
 - f. Viewpoint, Inc.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Contractor, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Sustainable design requirements.
 - o. Preparation of Record Documents.
 - p. Use of the premises and existing building.
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - x. Parking availability.
 - y. Office, work, and storage areas.
 - z. Equipment deliveries and priorities.
 - aa. First aid.
 - bb. Security.

- cc. Progress cleaning.
 - dd. List of major subcontractors and suppliers.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - f. Requirements for preparing operations and maintenance data.
 - g. Requirements for delivery of material samples, attic stock, and spare parts.
 - h. Requirements for demonstration and training.
 - i. Preparation of Contractor's punch list.
 - j. Procedures for processing Applications for Payment at Substantial Completion and for final payment including final change order.
 - k. Submittal procedures.
 - l. Coordination of separate contracts.
 - m. Owner's partial occupancy requirements including certificate of occupancy and closeout of permits.
 - n. Installation of Owner's furniture, fixtures, and equipment.
 - o. Responsibility for removing temporary facilities and controls.
 - p. Final cleaning.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction

behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- 1) Review schedule for next period.
- b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Status of sustainable design documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site use.
 - 10) Temporary facilities and controls.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of Proposal Requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Contractor will conduct Project coordination meetings at monthly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Attendees: In addition to representatives of Owner, Contractor, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of

schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

- b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013100

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Aerial and preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Final Completion construction photographs.
 - 5. Preconstruction video recordings.
 - 6. Periodic construction video recordings.
 - 7. Construction webcam.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
 - 4. Section 311000 "Site Clearing" for related information.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos on CD-ROM or thumb-drive or by uploading to web-based Project management software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in file metadata tag or in web-based Project management software site:
 - a. Name of Project.
 - b. Name and contact information for photographer.

- c. Name of Engineer.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- C. Video Recordings: Submit video recordings within seven days of recording.
1. Submit video recordings on CD-ROM or thumb drive or by uploading to web-based Project management software site. Include copy of key plan indicating each video's location and direction.
 2. Identification: With each submittal, provide the following information in file metadata tag or on web-based Project management software site:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.
- B. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with a record of providing satisfactory services similar to those required for Project.

1.5 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Metadata: Record accurate date and time from camera.
- E. File Names: Name media files with date Project area and sequential numbering suffix.

F. Usage Rights

1. Obtain and transfer copyright usage rights from photographer and videographer to Owner for unlimited reproduction of photographic and videographic documentation.

1.6 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs with maximum depth of field and in focus.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Preconstruction Photographs: Before commencement of the Work take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.

1. Flag excavation areas and construction limits before taking construction photographs.
2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:

1. Underground utilities.
2. Underslab services.
3. Piping.
4. Electrical conduit.
5. Waterproofing and weather-resistant barriers.
6. Fine and Coarse Bubble Diffusers.
7. Submersible Pumps.

E. Periodic Construction Photographs: Take 50 photographs monthly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. Aerial Photographs:

1. Provide aerial photography of the entire project site. Do not extend limits past the project boundary in order to provide the greatest level of detail of the entire work area.
2. Provide three different views at the following periods of the Project.
 - a. Prior to commencement of the Work.
 - b. Each month of construction.

- c. At project completion.
- G. Final Completion Construction Photographs: Take 100 photographs after date of Substantial Completion for submission as Project Record Documents. Engineer will inform photographer of desired vantage points.
- H. Additional Photographs: Engineer may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

1.7 CONSTRUCTION VIDEO RECORDINGS

- A. Video Recording Photographer: Engage a qualified videographer with not less than three years' experience to record construction video recordings.
- B. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
 - 1. Confirm date and time at beginning and end of recording.
 - 2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- C. Preconstruction Video Recording: Before starting excavation, demolition, or construction, record video recording of Project site and surrounding properties from different vantage points, as directed by Engineer.
 - 1. Flag construction limits before recording construction video recordings.
 - 2. Show existing conditions adjacent to Project site before starting the Work.
 - 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of excavation, demolition, or construction.
 - 4. Show protection efforts by Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013233

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SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Submittal schedule requirements.
- 2. Administrative and procedural requirements for submittals.

- B. Related Requirements:

- 1. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
- 2. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
- 3. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
- 4. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
- 5. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
- 6. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
- 7. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. Mass Submittals: Six or more submittals or items in one day or 15 or more submittals or items in one week.

1.4 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Engineer's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.5 SUBMITTAL FORMATS

- A. Numbering System: Utilize the following example submittal identification numbering system to identify submittals and as file names for PDF submissions:
1. First Identifier - Alphabet Character: D, S, M, or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
 2. Second Identifier - Next 6 or 8 Digits: Applicable Specification Section Number. Do not mix submittals from different specification sections into a single submittal.
 3. Third Identifier - Next Three Digits: Sequential number of each separate item or drawing submitted under each Specification Section, in chronological order submitted, starting at 001.
 4. Fourth Identifier - Last Alphabet Character: A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc.
 5. EXAMPLE: D-033000.13-008-B.

- a. D = Shop Drawing.
 - b. 033000.13 = Section; use only 6 digits for sections that do not include 8 digits.
 - c. 008 = the eighth different submittal under this Section.
 - d. B = the second submission (first resubmission) of that particular shop drawing.
- B. Submittal Information: Include the following information in each submittal:
1. Project name.
 2. Date.
 3. Name of Engineer.
 4. Name of Contractor.
 5. Name of firm or entity that prepared submittal.
 6. Names of subcontractor, manufacturer, and supplier.
 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 8. Category and type of submittal.
 9. Submittal purpose and description.
 10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 11. Drawing number and detail references, as appropriate.
 12. Indication of full or partial submittal.
 13. Location(s) where product is to be installed, as appropriate.
 14. Other necessary identification.
 15. Remarks.
 16. Signature of transmitter.
- C. Options: Identify options requiring selection by Engineer.
- D. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- E. Paper Submittals: For Operation and Maintenance Manuals only.
1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
 2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
- F. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- G. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.6 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package and transmit to Engineer by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer.
 - a. Engineer will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 30 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 30 working days for review of each resubmittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

4. Repetitive Reviews: Shop drawings, O&M manuals, and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at the Contractor's expense. Reimburse the Owner for all costs invoiced by Engineer for the third and subsequent reviews.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.7 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Engineer's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.

- c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.
 4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 6. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
 7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit two sets of Samples. Engineer will retain one Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.

- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

- G. Certificates:
 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Contractor's Certification: Each shop drawing, working drawing, product data, and sample shall have affixed to it the following Certification Statement:
 - a. "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements. "
 3. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 4. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

5. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
6. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
7. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.8 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.

- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.9 PROPOSED PRODUCT LIST

- A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.10 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Contractor Responsible for:
 - 1. Determination and verification of materials including manufacturer's catalog numbers.
 - 2. Determination and verification of field measurements and field construction criteria.
 - 3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
 - 4. Determination of accuracy and completeness of dimensions and quantities.
 - 5. Confirmation and coordination of dimensions and field conditions at Site.
 - 6. Construction means, techniques, sequences, and procedures.
 - 7. Safety precautions.
 - 8. Coordination and performance of Work of all trades.
 - 9. Other requirements enumerated in Contract Documents.
- C. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp or indication in web-based Project management software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.11 ENGINEER'S REVIEW

- A. Do not make mass submittals to Engineer. If mass submittals are received, Engineer's review time stated above will be extended as necessary to perform proper review. Engineer will review mass submittals based on priority determined by Engineer after consultation with Owner and Contractor.
- B. Action Submittals: Engineer will review each submittal, indicate corrections or revisions required, and return.
 - 1. PDF Submittals: Engineer and Construction Manager will indicate, via comments on the submittal response form, the appropriate action.
 - 2. Submittals by Web-Based Project Management Software: Engineer will indicate, on Project management software website, the appropriate action.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Engineer will return without review submittals received from sources other than Contractor.
- G. Submittals not required by the Contract Documents will be returned by Engineer without action.
- H. Shop drawings will be returned to Contractor with one of the following codes.
 - 1. "APPROVED" - This code is assigned when there are no notations or comments on the submittal. When returned under this code Contractor may release the equipment and/or material for manufacture.
 - 2. "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by Contractor. Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
 - 3. "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. The resubmittal is to address all comments, omissions and non-conforming items that were noted. An additional box is checked to indicate whether the resubmission is for the complete package, or for parts of the package. If no box is checked, a complete resubmittal shall be provided. Review code may designate if a partial or full submittal is required. If full submittal is required, a complete resubmittal package addressing all comments shall be provided. If a partial submittal is designated, resubmittal shall only include information pertaining to those items noted in review comments requiring clarification and any portions of submittal impacted as a result of the response. Resubmittal is to be received by Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

4. "REJECTED" - This code is assigned when the submittal does not meet the intent of the Contract Documents. Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the Contract Documents.
5. "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Approval)" - This code is assigned to acknowledge receipt of a submittal that is not subject to Engineer's approval. This code is generally used with submittals involving Contractor's means and methods of construction work plans, and health and safety plans.

1.12 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

- A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.
- B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:
 1. Use of files is solely at receiver's risk. Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
 2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
 3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.
 4. Receiver shall not hold Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
 5. Receiver shall understand that even though Engineer has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
 6. Receiver shall not hold Engineer responsible for such viruses or their consequences, and shall hold Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013300

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SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated, and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance

with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

- E. **Product Tests:** Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. **Source Quality-Control Tests and Inspections:** Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- G. **Testing Agency:** An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" shall have the same meaning as the term "testing agency."
- H. **Quality-Assurance Services:** Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- I. **Quality-Control Services:** Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.4 DELEGATED DESIGN SERVICES

- A. **Performance and Design Criteria:** Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. **Delegated Design Services Statement:** Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.5 CONFLICTING REQUIREMENTS

- A. **Conflicting Standards and Other Requirements:** If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Engineer for clarification before proceeding.

- B. **Minimum Quantity or Quality Levels:** The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.6 INFORMATIONAL SUBMITTALS

- A. **Contractor's Quality-Control Plan:** For quality-assurance and quality-control activities and responsibilities.
- B. **Qualification Data:** For Contractor's quality-control personnel and Delegated-Designer.
- C. **Contractor's Statement of Responsibility:** When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. **Testing Agency Qualifications:** For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. **Schedule of Tests and Inspections:** Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. **Reports:** Prepare and submit certified written reports and documents as specified.
- G. **Permits, Licenses, and Certificates:** For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
- B. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- C. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 - 3. Owner-performed tests and inspections indicated in the Contract Documents.
- D. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- E. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include Work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.

10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.9 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Design Professional Qualifications:** A professional engineer / registered architect who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Design / engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged in the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing and Inspecting Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect, demonstrate, repair and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.10 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.
- B. **Contractor Responsibilities:** Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payments.
1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 2. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Engineer.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's and authorities' having jurisdiction reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

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SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.
 - 1. AABC - Associated Air Balance Council; www.aabc.com.
 - 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 - 3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
 - 4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 - 5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
 - 6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 - 7. ABMA - American Boiler Manufacturers Association; www.abma.com.
 - 8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org
 - 9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
 - 10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 - 11. AF&PA - American Forest & Paper Association; www.afandpa.org.
 - 12. AGA - American Gas Association; www.aga.org.
 - 13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 - 14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 - 15. AI - Asphalt Institute; www.asphaltinstitute.org.
 - 16. AIA - American Institute of Architects (The); www.aia.org.
 - 17. AISC - American Institute of Steel Construction; www.aisc.org.
 - 18. AISI - American Iron and Steel Institute; www.steel.org.
 - 19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
 - 20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 - 21. ANSI - American National Standards Institute; www.ansi.org.
 - 22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
 - 23. APA - APA - The Engineered Wood Association; www.apawood.org.
 - 24. APA - Architectural Precast Association; www.archprecast.org.
 - 25. API - American Petroleum Institute; www.api.org.
 - 26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
 - 27. ARI - American Refrigeration Institute; (See AHRI).

28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformance Europeenne; <http://ec.europa.eu/growth/single-market/ce-marking/>
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csagroup.com.
65. CSA - CSA International; www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).

73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.
89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. ICBO - International Conference of Building Officials; (See ICC).
101. ICC - International Code Council; www.iccsafe.org.
102. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
103. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
104. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
105. IEC - International Electrotechnical Commission; www.iec.ch.
106. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
107. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
108. IESNA - Illuminating Engineering Society of North America; (See IES).
109. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
110. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
111. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
112. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
113. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
114. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
115. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).

116. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
117. ISO - International Organization for Standardization; www.iso.org.
118. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
119. ITU - International Telecommunication Union; www.itu.int/home.
120. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
121. LMA - Laminating Materials Association; (See CPA).
122. LPI - Lightning Protection Institute; www.lightning.org.
123. MBMA - Metal Building Manufacturers Association; www.mbma.com.
124. MCA - Metal Construction Association; www.metalconstruction.org.
125. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
126. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
127. MHIA - Material Handling Industry of America; www.mhia.org.
128. MIA - Marble Institute of America; www.marble-institute.com.
129. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
130. MPI - Master Painters Institute; www.paintinfo.com.
131. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
132. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
133. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
134. NADCA - National Air Duct Cleaners Association; www.nadca.com.
135. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
136. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
137. NBI - New Buildings Institute; www.newbuildings.org.
138. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
139. NCMA - National Concrete Masonry Association; www.ncma.org.
140. NEBB - National Environmental Balancing Bureau; www.nebb.org.
141. NECA - National Electrical Contractors Association; www.necanet.org.
142. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
143. NEMA - National Electrical Manufacturers Association; www.nema.org.
144. NETA - InterNational Electrical Testing Association; www.netaworld.org.
145. NFHS - National Federation of State High School Associations; www.nfhs.org.
146. NFPA - National Fire Protection Association; www.nfpa.org.
147. NFPA - NFPA International; (See NFPA).
148. NFRC - National Fenestration Rating Council; www.nfrc.org.
149. NHLA - National Hardwood Lumber Association; www.nhla.com.
150. NLGA - National Lumber Grades Authority; www.nlga.org.
151. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
152. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
153. NRCA - National Roofing Contractors Association; www.nrca.net.
154. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
155. NSF - NSF International; www.nsf.org.
156. NSPE - National Society of Professional Engineers; www.nspe.org.
157. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
158. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
159. NWFA - National Wood Flooring Association; www.nwfa.org.
160. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
161. PDI - Plumbing & Drainage Institute; www.pdionline.org.

162. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
163. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
164. RFCI - Resilient Floor Covering Institute; www.rfci.com.
165. RIS - Redwood Inspection Service; www.redwoodinspection.com.
166. SAE - SAE International; www.sae.org.
167. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
168. SDI - Steel Deck Institute; www.sdi.org.
169. SDI - Steel Door Institute; www.steeldoor.org.
170. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
171. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
172. SIA - Security Industry Association; www.siaonline.org.
173. SJI - Steel Joist Institute; www.steeljoist.org.
174. SMA - Screen Manufacturers Association; www.smainfo.org.
175. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
176. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
177. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
178. SPIB - Southern Pine Inspection Bureau; www.spib.org.
179. SPRI - Single Ply Roofing Industry; www.spri.org.
180. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
181. SSINA - Specialty Steel Industry of North America; www.ssina.com.
182. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
183. STI - Steel Tank Institute; www.steeltank.com.
184. SWI - Steel Window Institute; www.steelwindows.com.
185. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
186. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
187. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
188. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
189. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
190. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
191. TMS - The Masonry Society; www.masonrysociety.org.
192. TPI - Truss Plate Institute; www.tpinst.org.
193. TPI - Turfgrass Producers International; www.turfgrasssod.org.
194. TRI - Tile Roofing Institute; www.tilerroofing.org.
195. UL - Underwriters Laboratories Inc.; <http://www.ul.com>.
196. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
197. USAV - USA Volleyball; www.usavolleyball.org.
198. USGBC - U.S. Green Building Council; www.usgbc.org.
199. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
200. WA - Wallcoverings Association; www.wallcoverings.org.
201. WASTEC - Waste Equipment Technology Association; www.wastec.org.
202. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
203. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
205. WI - Woodwork Institute; www.wicnet.org.
206. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.

207. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).

4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from DLA Document Services;
www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
 6. MILSPEC - Military Specification and Standards; (See DOD).
 7. USAB - United States Access Board; www.access-board.gov.
 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).
- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
 2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
 3. CDHS; California Department of Health Services; (See CDPH).
 4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservation.tamu.edu.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section CIP3 “Summary of Work” for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use. Provide connections and extensions of services as required for construction operations.
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use with metering. Provide connections and extensions of services and metering as required for construction operations.
- G. Contractor shall refer to Section 00700 “General Conditions” regarding permanent utilities connections.

1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Refer to Specification CIP 15 “Project Identification Signage.”
- D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 - 3. Indicate methods to be used to avoid trapping water in finished work.
- F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste-handling procedures.
 - 5. Other dust-control measures.
- G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
 - 1. Methods used to meet the goals and requirements of the Owner.
 - 2. Concrete cutting method(s) to be used.
 - 3. Location of construction devices on the site.
 - 4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.

5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.
6. Indicate locations of sensitive equipment areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

1.5 QUALITY ASSURANCE

- A. Temporary facilities shall comply with all applicable state and local ordinances, codes, and regulations.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- D. Accessible Temporary Egress: Comply with applicable provisions in 2012 Texas Accessibility Standards (TAS).

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Temporary Chain-Link Fencing: Minimum 2 inch thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8 inch OD line posts and 2-7/8 inch OD corner and pull posts, with 1-5/8 inch OD top rails.
- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Engineer from manufacturer's standard colors.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.
- D. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 inches by 60 inches.
- E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES



- A. Field Offices: Field engineer's office is not required.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where shown on Drawings or where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work. Engineer's trailer shall be set up and ready for occupancy within 30 days of the Notice to Proceed.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use within 30 days of the Notice to Proceed and prior to Commencement of Work at the site. Do not remove until approved by Engineer or are replaced by authorized use of completed permanent facilities.

3.3 ENGINEER'S OFFICE

- A. Engineer's trailer shall be set up and ready for occupancy within 30 days of the Notice to Proceed and prior to commencement of Work at the site. All systems, furnishings, equipment, and services specified herein shall be furnished, installed, and completely operational for the field office to be considered established.
 1. Provide regular office cleaning services for the duration of the project.
 2. Provide supplies including, but not limited to restroom supplies (toilet tissue paper, paper towel, and soap), as well as light bulbs, air conditioner filters, etc.
 3. Provide office supplies for printers and fax machines, etc.
 4. Supply all fuel for heating and pay all utility bills.
- B. Install field office plumb and level.
- C. Engineer's trailer shall be removed, and the site shall be cleaned up and restored before Final Completion of the project.

3.4 CONTRACTOR'S FIELD OFFICE

- A. Provide a temporary field office(s) for Contractor's use for the duration of the project. An authorized representative of Contractor shall be present at all times while the Work is in progress. Instructions received at Contractor's field office from Engineer shall be considered delivered to Contractor.
- B. Locate field office(s) in accordance with approved shop drawings and as directed by Owner.
- C. Establish and occupy field office within 30 days of the Notice to Proceed, unless otherwise approved by Engineer or Owner.

3.5 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service, if approved by Owner.
 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Water Service: If approved, connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Final Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- F. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. Temporary Light and Power: Provide by Contractor, including 220 Volt service for welding, complete with wiring, lamps and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the project needs. Make all necessary arrangements with the local electric company for temporary electric service and pay all expenses in connection therewith.
- I. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

- J. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service overhead unless otherwise indicated.
 - 2. Connect temporary service to Owner's existing power source, as directed by Owner. Provide any necessary metering equipment and appurtenances to make the connection.
- K. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- L. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Engineer and Owner.

3.6 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 - 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 - 2. Utilize designated area within existing building for temporary field offices.
 - 3. Maintain support facilities until Engineer schedules Final Completion inspection. Remove just before Final Completion.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
 - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas accordance with Section 312000 "Earthwork."
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

- D. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- E. Parking: Provide temporary parking areas for construction personnel.
- F. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- H. Project Signs: Provide Project signs as indicated in Section CIP 15 "Project Identification Signage".
- I. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- J. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- K. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- L. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- M. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.
- N. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.7 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 1. Comply with work restrictions specified in Section CIP3 “Summary of Work.”
- C. Temporary Erosion and Sedimentation Control: Comply with requirements specified in Section 311000 "Site Clearing" and CIP 9 “environmental Protection Procedures.”
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways.
 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- F. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- H. Site Enclosure Fence: Before construction operations begin or Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 1. Extent of Fence: As indicated on Drawings.
 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner and Engineer’s Field Representative.
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide, install and maintain signage directing occupants to temporary egress.
- L. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings.
 - 1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 - 2. Paint and maintain appearance of walkway for duration of the Work.
- M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- N. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard, with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Construct dustproof partitions with two layers of 6 mil polyethylene sheet on each side. Cover floor with two layers of 10 mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
 - 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 4. Insulate partitions to control noise transmission to occupied areas.
 - 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 6. Protect air-handling equipment.
 - 7. Provide walk-off mats at each entrance through temporary partition.
- O. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.
- P. Weather protection shall comply with M.G.L. Chapter 149 Section 44G.

3.8 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

- a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
- b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer.
- c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.9 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 2. Clear snow and ice from all drives, walks and stairs to maintain safe vehicle and pedestrian access to the site and facilities as directed by the Engineer.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Final Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Final Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. Just prior to Final Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

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SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

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 protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for temporary site fencing.

1.3 DEFINITIONS

- A. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape or the average of the smallest and largest diameters at a height 54 inches above the ground line for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground.
- B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Tree-service firm's personnel, and equipment needed to make progress and avoid delays.
 - b. Arborist's responsibilities.
 - c. Quality-control program.
 - d. Coordination of Work and equipment movement with the locations of protection zones.

- e. Trenching by hand or with air spade within protection zones.
- f. Field quality control.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
 - 2. Detail fabrication and assembly of protection-zone fencing and signage.
 - 3. Indicate extent of trenching by hand or with air spade within protection zones.
- C. Samples: For each type of the following:
 - 1. Organic Mulch: 1-pint volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
 - 2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
 - 3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.
- D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
 - 1. Species and size of tree.
 - 2. Location on site plan. Include unique identifier for each.
 - 3. Reason for pruning.
 - 4. Description of pruning to be performed.
 - 5. Description of maintenance following pruning.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For arborist and tree service firm.
- B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

- E. Quality-control program.

1.7 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.8 FIELD CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Moving or parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Soil: Stockpiled soil mixed with planting soil of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
 - 1. Mixture: Well-blended mix of two parts stockpiled soil to one part planting soil.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood, or Ground or shredded bark, or Wood and bark chips.
 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 3. Color: Natural.
- C. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements: Previously used materials may be used when approved by Engineer.
1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch- diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- OD line posts, and 2-7/8-inch- OD corner and pull posts; with 1-5/8-inch- OD top rails; with 0.177-inch- diameter top tension wire and 0.177-inch- diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
 - a. Height: 72 inches.
 2. Gates: Single- or Double- swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 24 inches or 36 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.
1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

3.3 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance

gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

- B. Maintain protection zones free of weeds and trash.
- C. Maintain protection-zone fencing and signage in good condition as acceptable to Engineer and remove when construction operations are complete and equipment has been removed from the site.
 - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 - 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earthwork" unless otherwise indicated.
- B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

- A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as approved by local arborist. Consult local arborist and gain approval for all trees requiring root pruning prior to beginning any pruning work.
- B. Root Pruning at Edge of Protection Zone: Prune tree roots 12 inches outside of the protection zone by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use

narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as directed by arborist.
 - 1. Prune to remove only broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
 - 2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
 - 3. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
- B. Unless otherwise directed by arborist and acceptable to Engineer, do not cut tree leaders.
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Do not paint or apply sealants to wounds.
- E. Provide subsequent maintenance pruning during Contract period as recommended by arborist.

3.7 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
 - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Engineer.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

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SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section CIP 3 "Summary of Work" for Contractor requirements related to Owner-furnished products.
 - 2. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 3. Section 014200 "References" for applicable industry standards for products specified.
 - 4. Section 017700 "Closeout Procedures" for submitting warranties.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycle contract materials are considered new products, unless indicated otherwise.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 1. Resolution of Compatibility Disputes between Multiple Contractors:
 - a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.

2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
3. See individual identification Sections in Divisions 22, 23, and 26 for additional equipment identification requirements.

1.5 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.
- C. Storage:
 1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
 2. Store products to allow for inspection and measurement of quantity or counting of units.
 3. Store materials in a manner that will not endanger Project structure.
 4. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection for wind.
 5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Engineer will make selection.

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Engineer in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Engineer, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

- a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Engineer's sample," provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance the following requirements:
 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type,

- function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of Engineers and owners, if requested.
 5. Samples, if requested.
- B. Engineer's Action on Comparable Products Submittal: If necessary, Engineer will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."
1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
 2. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by the Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.
- D. Submittal Requirements, Single-Step Process: When acceptable to Engineer, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Engineer of Contractor' request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 016000

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SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner's portion of the Work.
6. Coordination of Owner-installed products.
7. Progress cleaning.
8. Starting and adjusting.
9. Protection of installed construction.

- B. Related Requirements:

1. Section CIP 3 "Summary of Work" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Engineer of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
 - a. Contractor's superintendent.
 - b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.
 - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.6 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

- C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements, whose structural function is not known, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Plumbing piping systems.
 - f. Mechanical systems piping and ducts.
 - g. Control systems.
 - h. Communication systems.
 - i. Fire-detection and -alarm systems.
 - j. Conveying systems.
 - k. Electrical wiring systems.
 - l. Operating systems of special construction.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- B. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

- C. **Written Report:** Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work, including Specification Section number and paragraphs, and Drawing sheet number and detail, where applicable.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. **Existing Utility Information:** Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. **Field Measurements:** Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. **Review of Contract Documents and Field Conditions:** Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer in accordance to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. **Verification:** Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Engineer promptly.
- B. **Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices.**
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.

7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Engineer. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items onsite and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with

integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Engineer. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
 - 1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Engineer. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
 4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 degrees F.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.9 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- D. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

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SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
- B. Related Requirements:
 - 1. Section CIP14 "Project Closeout" for City requirement. This specification supplements these requirements.
 - 2. Section CIP 16 "Warranty."
 - 3. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 4. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 5. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 6. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for Engineer's use prior to Engineer's inspection, to determine if the Work is substantially complete.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.5 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.
 - 5. Submit testing, adjusting, and balancing records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.8 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit Final Completion photographic documentation.

- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Organize list of spaces in sequential order, starting with exterior areas first, listed by room or space number.
 - 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 - 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Page number.
 - 4. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File. Engineer will return annotated file.

1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Submit warranty, bond, service, and maintenance contract documentation associated with the work performed.
- B. Warranty period: Refer to CIP 16 “Warranty”, Division 40, and Division 46 for specific Equipment Warranties.
- C. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- D. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

- E. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- F. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 - 1. Submit on digital media acceptable to Engineer, by uploading to web-based project software site, or by email to Engineer.
- G. Warranties in Paper Form:
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- H. Provide additional copies of each warranty to include in operation and maintenance manuals.

1.11 PROJECT RECORD DOCUMENTS

- A. Maintain record documents as specified under Section CIP 14 "Project Closeout" and CIP14.02 Record Documents inclusive of those documents specified therein and also including:
 - 1. Field Test Records.
 - 2. Correspondence.
- B. Make available all documents to Owner's Inspector when requested.
- C. Keep record drawings current.
- D. Do not permanently conceal any work until required information has been recorded.
- E. Label each drawing "CONSTRUCTION AS-BUILT" in neat, large, printed letters. Legibly mark drawings to record actual construction as required under CIP 14.02, Item E and also including:
 - 1. Manufacturer, trade name, catalog number and supplier of all products and equipment actually installed.
 - 2. Changes made by change order or field order.
- F. Indicate all changes legibly in a contrasting color.
- G. Delete Architect/Engineer seal from all record drawings.

- H. Submit record drawings in compliance with CIP14.02, F. and accompany submittal with a transmittal letter, containing:
 - 1. Date.
 - 2. Project title and number.
 - 3. Contractor's name and address.
 - 4. Contents of submittal.
 - 5. Certification that record drawings as submitted are complete and accurate.
 - 6. Signature of Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning as required under CIP 14.04 Final Cleaning.
- B. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. For Draft O&M Manuals, submit on digital media acceptable to Engineer or by uploading to web-based project software site. Enable reviewer comments on draft submittals.
 - 2. After approval of Final O&M Manuals, submit two paper copies and final electronic copy.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Engineer will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.
 - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

- b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Engineer.
 7. Name and contact information for Commissioning Authority.
 8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 ASSET MANAGEMENT FORM

- A. Asset Management Form: Prepare a list of installed equipment. The list will include the equipment's location, date of installation, description, position, category, manufacturer, serial number, and model. Refer to example at the end of this Section.

1.8 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.9 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 1. Fire.

2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.10 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.11 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent,

and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

- D. **Manufacturers' Maintenance Documentation:** Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- E. **Maintenance Procedures:** Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- F. **Maintenance and Service Schedules:** Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. **Scheduled Maintenance and Service:** Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. **Maintenance and Service Record:** Include manufacturers' forms for recording maintenance.
- G. **Spare Parts List and Source Information:** Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. **Maintenance Service Contracts:** Include copies of maintenance agreements with name and telephone number of service agent.
- I. **Warranties and Bonds:** Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

- 1. Do not use original project record documents as part of maintenance manuals.

1.12 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 Submittal Schedule

- A. Operation and maintenance manuals shall be delivered directly to the office of the Engineer, as follows:
1. Provide preliminary copies of each manual to the office of the Engineer, no later than 30 days following approval of the respective shop drawings.
 2. Provide final copies of each completed manual prior to testing.
 3. Provide a letter that grants the Engineer and Owner to the limited right to use and reproduce each manual (in its entirety or any portion thereof) from the respective equipment manufacturer(s). Such limited right shall allow the Engineer and Owner to use each manual or any portion thereof for:
 - a. The potential assembly of a comprehensive facility operation and maintenance manual for the sole benefit of the Owner; and,
 - b. supplemental training of the Owner's personnel and operators, over and above the required vendor's training, regarding operation of the facility as a system.
 4. For each submitted manual, complete and submit to the Engineer the O&M Manual Review Checklist, appended to this Section.
- B. The Engineer will review Operation and Maintenance manuals submittals for operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the O&M Manual Review Checklist appended to this Section.
- C. If during test and start-up of equipment, any changes were made to the equipment, provide two hard copies of as-built drawings or any other amendments for insertion, by the contractor, in the previously transmitted final manuals. In addition, provide one revised electronic version including the as-built drawings and any other amendments. The manuals shall be completed, including updates, if any, within 30 days of start-up and testing of the facility.
- D. As applicable, complete and submit the Equipment Manufacturer's Certificate of Installation Testing and Instruction, appended to this Section, within 30 days after final inspection and plant start-up testing.

3.2 VENDOR TRAINING/INSTRUCTIONS (TO OWNER'S PERSONNEL)

- A. Before final initiation of operation, Contractor's vendors shall train/instruct Owner's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the Owner.
- B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of eight hours of training for each type of equipment. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of

Owner's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the Contractor's "normal working hours" or the Owner's normal day shift.

- C. Use operation and maintenance manuals as basis for instruction. Train/instruct the Owner's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.
- D. At least two weeks prior to the schedule for vendor training, a detailed lesson plan, representative of the material to be covered during instruction, shall be submitted to the Engineer for approval. Lesson plans shall consist of in-depth outlines of the training material, including a table of contents, resume of the instructor, materials to be covered, start-up procedures, maintenance requirements, safety considerations, and shut-down procedures.
- E. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.
- F. Vendor's training/instruction will be considered acceptable based on the completed Owner's Acknowledgement of Manufacturer's Instruction as indicated on the Equipment Manufacturer's Certification of Installation, Testing, and Instruction appended to this Section.

EQUIPMENT MANUFACTURER'S CERTIFICATE
OF INSTALLATION TESTING AND INSTRUCTION

Owner: _____

Project: _____

Contract No.: _____

CDM No.: _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I, _____, Authorized representative of
(PRINT NAME)

(PRINT MANUFACTURER'S NAME)

hereby CERTIFY that _____
(PRINT EQUIPMENT NAME AND MODEL WITH SERIAL NO.)

installed for the subject project [has] [have] been installed in a satisfactory manner, [has] [have] been satisfactorily tested, [is] [are] ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on Date: _____
Time: _____.

CERTIFIED BY: _____ DATE: _____
(SIGNATURE OF MANUFACTURER'S REPRESENTATIVE)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

[I] [We] the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and [am] [are] prepared to assume normal operational responsibility for the equipment:

DATE: _____

DATE: _____

DATE: _____

O&M Manual Review Checklist

Submittal No.: _____

Project No.: _____

Manufacturer: _____

Equipment Submitted: _____

Specification Section: _____

Date of Submittal:

General Data		
1.	Are the area representative's name, address, e-mail address and telephone number included?	
2.	Is the nameplate data for each component included?	
3.	Are all associated components related to the specific equipment included?	
4.	Is non-pertinent data crossed out or deleted?	
5.	Are drawings neatly folded and/or inserted into packets?	
6.	Are all pages properly aligned and scanned legibly?	
7.	Is the .PDF document bookmarked according to the table of contents?	
Operations and Maintenance Data		
8.	Is an overview description of the equipment and/or process included?	
9.	Does the description include the practical theory of operation?	
10.	Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)?	
11.	Are alarm and shutdown conditions specific to the equipment provided on this project clearly identified? Does it describe possible causes and recommended remedies?	
12.	Are step procedures for starting, stopping, and troubleshooting specific to the equipment provided included?	
13.	Is a list of operational parameters to monitor and record specific to the equipment provided included?	
14.	Is a proposed operating log sheet specific to the equipment provided included?	
15.	Is a spare parts inventory list included for each component?	
16.	Is a lubrication schedule for each component specific to the equipment provided included - or does it clearly state "No Lubrication Required"?	
17.	Is a maintenance schedule for each component specific to the equipment provided included?	
18..	Is a copy of the warranty information included?	

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Asset Management Form- Example

Asset # - To be assigned by the City of Georgetown	Location - Address	Internal Site Location	Commission Date - Date Accepted	Description	Position	Category	Manufacturer	Serial Number	Model	Revision	Organizati	Department	Items that are considered assests and should be reflected in the form are listed below. City of Georgetown may require additional items to be captured as needed. Pumps Motors Motor Starters
	1010 Crockett Gardens	HSPS - Pump Pad	5/31/2025	High Service Pump	Pump #1	Centrifugal	FlowsERVE	2012NNH00121-1	VPC-15FBL-2		GUS	U-WOPS	
	1011 Crockett Gardens	HSPS - Pump Pad	5/31/2026	Cla-valve	Pump #1	Valve	Cla Val	60-08-366F	16" 60-08BY		GUS	U-WOPS	
	1012 Crockett Gardens	HSPS - Pump Pad	5/31/2027	Solenoid	Pump #1	Solenoid	ACSOX	22027005	16" 60-08BY		GUS	U-WOPS	

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for final property survey.
 - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - 3) Submit Record Digital Data Files and one set(s) of plots.
 - 4) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit Record Digital Data Files and three set(s) of Record Digital Data File plots.

- 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Work Change Directive.
 - k. Changes made following Engineer's written orders.
 - l. Details not on the original Contract Drawings.

- m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings.
 2. Format: DWG
 3. Format: Annotated PDF electronic file with comment function enabled.
 4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 5. Refer instances of uncertainty to Engineer for resolution.
 6. Engineer will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Engineer's digital data files.
 - b. Engineer will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 - 5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.
- B. Format: Submit Record Specifications as annotated PDF electronic file.

1.6 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.
- C. Format: Submit Record Product Data as annotated PDF electronic file.
 - 1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours. As a prerequisite for monthly progress payments, exhibit the updated record documents for review by Owner and Engineer for accuracy and completeness.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017839

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SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Engineer.

- d. Name of Contractor.
 - e. Date of video recording.
2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
 3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
 4. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 1. Inspect and discuss locations and other facilities required for instruction.
 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 3. Review required content of instruction.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.

1.7 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.

- c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral and a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode.
 - 1. Submit video recordings on thumb drive and/or by uploading to web-based Project software site.
 - 2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.

4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
 1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017900

SECTION 018819 - TIGHTNESS TESTING PERFORMANCE REQUIREMENTS

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. Tightness testing of cast-in-place reinforced concrete liquid retaining structures.

- B. Related Requirements:

- 1. Section 031500 "Concrete Joints and Accessories" for joints in concrete structures.
 - 2. Section 033000 " Cast-In-Place Concrete" for concrete related construction.
 - 3. Section 400551 "Common Requirements for Process Valves" for valves and valve actuators.

1.3 INFORMATIONAL SUBMITTALS

- A. Submit in accordance with Section 013300 "Submittal Procedures":

- 1. Action Plan: Submit a detailed plan and schedule for each structure, which shows method of filling, testing and disposal of water.
 - 2. Repair Procedures: Submit for acceptance the proposed repair methods, materials, and modifications needed, if structure does not meet tightness testing.
 - 3. Test Reports: Submit a completed Tightness Test Report, Figure A, appended at the end of this Section of each test for each structure.

1.4 FIELD CONDITIONS

- A. Coordinate timing and procedures for obtaining water for testing, structure testing, and water disposal with the Owner a minimum of 30 days in advance of actual testing.

- B. Water Source:

- 1. Provide water for testing independent from Owner's water source.
 - 2. Use water for testing from Owner's plant water system. Obtain water at a time, flow rate, and location approved by Owner.
 - 3. Provide labor, materials, equipment, incidentals, and power required to convey water to the structure.

C. Water Disposal:

1. Dispose of test water in an approved manner. Do not dispose by discharging onto the ground surface of public or private land.
2. Coordinate disposal of test water by reintroduction into the Plant process at a time, flow rate, and location with Owner.
3. Provide labor, materials, equipment, incidentals, and power required to convey water from the structure.

D. Environmental Conditions: Do not schedule test measurements for a period when the weather forecast indicates a substantial change in weather patterns that would affect testing. Do not schedule test measurements when weather forecast indicates water surface would be frozen before test is completed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform tightness testing of cast-in-place reinforced concrete liquid retaining structures conforming to ACI 350.1 and as specified herein.
- B. Perform tightness tests prior to waterproofing and dampproofing and prior to placing backfill around structures in order to permit observation and detection of leakage points.
- C. Individually test each cell of multi-cell tanks.
- D. Multi-cell tanks may be tested as a single unit where indicated.

3.2 PREPARATION

- A. Remove soil, mud, debris and all other contaminants from structures prior to initiating tightness tests. Flush floor and sumps with water to provide a clean surface that is ready for testing.
- B. Prior to testing, temporarily seal or bulkhead inlet and outlet pipes not required to be operational for testing procedures.
- C. Confirm that valves, slide gates, and watertight access/ hatch doors are completely closed. Repair and reset seals that do not completely close or leak. Test valves, slide gates, and watertight access doors for leakage in accordance with requirements of respective Sections as part of the preparation for final tightness testing under this Section.

3.3 EXAMINATION

- A. Examine structures to be tested for potential leakage paths including cracks, voids, honeycombs, and unsealed joints. Repair such paths to prevent leakage prior to testing.

- B. Proceed with testing only after unsatisfactory conditions have been corrected.

3.4 TESTING PROCEDURES

A. Testing Conditions:

1. Do not begin filling of reinforced concrete structure until concrete elements of the structure have attained specified design strength, but not less than 14 days after placement of all concrete elements.
2. Fill reinforced concrete structure not exceeding a rate of 4 feet per 1 hour.
3. To minimize water absorption by concrete during testing, fill reinforced concrete structure to maximum operating water surface level and maintain water at that level for at least 3 days, prior to beginning tightness tests. Observe the exterior surfaces of the structure in both the early mornings and late afternoons during 3 days prior to tightness testing. Note any water observed on the structure exterior surfaces.
4. Test only a single structure at a time. Concurrent testing of contiguous or adjacent structures will not be allowed.

B. Testing Procedures:

1. Test Duration / Test Period: At least the time required to lower the water surface 3/8 inch (9.5 mm), assuming a loss of water at the maximum allowable rate, but not longer than 5 days
2. Measure water surface elevations at 24-hour intervals. The vertical distance to the water surface shall be measured to within 1/16 inch from a fixed point on the structure above the water surface. Measure water surface elevations at the same four locations, 90 degrees apart. Record water temperature 18 inches below water surface when taking the first and last sets of measurements.
 - a. Use methods to determine amount of precipitation or evaporation as approved by the Engineer.
3. Compute percentage of water volume loss based on measured change in water surface elevation, area of the horizontal water surface, initial water volume, and correction for precipitation or evaporation where applicable.
4. Restart test when test measurements become unreliable due to unusual precipitation or other external factors.

C. Reports: Prepare and submit as referenced in this Section.

3.5 ACCEPTANCE

- #### A. Following conditions are considered as not meeting the criteria for acceptance, regardless of actual loss of water volume from the structure:
1. Groundwater seeping or flowing into the structure through floors, walls, or wall-floor joints.
 2. Structures which exhibit seeping or flowing water from joints, cracks, voids, honeycombs, or from beneath the foundation.

3. Increased flow from underdrain system during tightness testing.
 4. Damp spots on concrete surfaces.
 5. Moisture can be deposited on a dry hand held against the exterior surface of the structure.
- B. Tightness of concrete tanks and structures will be considered acceptable when the conditions of conditions included in paragraph above are not present and when loss of water volume does not exceed 0.05 percent of the starting volume per day.

3.6 REPAIRS AND RETESTING

- A. Structures failing the tightness test and not exhibiting visible leakage may be retested after an additional stabilization period of 7 days. Structures failing this second test shall be repaired prior to further testing.
- B. Retest repaired structures until the structure meets all requirements.

3.7 SCHEDULE



- A. Test following structures for tightness:
1. Tank types include:
 - a. Sodium Bisulfite Facility – new containment area detailed on SG-SF-1.
 2. Wet well types include:
 - a. Influent Channel upstream of wet well detailed on SG-SA sheets.

END OF SECTION 018819

**FIGURE A
TIGHTNESS TEST REPORT**

PROJECT _____ SUBMITTED BY _____

STRUCTURE * _____ TEST DATES _____

Allowable loss of water volume _____ percent in 24 hours

Measured loss of water volume _____ percent in 24 hours

TEST READINGS

Water Temperature at Start _____ [_____] degrees F

Water Temperature at End _____ [_____] degrees F

Operating Water Surface Level _____

Entry	Date**	Time	Water Surface Elevation				Initials**
			Location 1	Location 2	Location 3	Location 4	
0							
1							
2							
3							
4							
5							
Change in level (difference between entry 5 and entry 0)							
Average change in level (sum of change in level / 4)							
Correction for precipitation/evaporation							
Corrected change in level = CL =							
Measured percent water loss in 24 hrs. =			$\frac{(CL) \times (\text{surface area}) \times (100)}{(\text{initial water volume}) (\text{number of test days})}$				

Notes and Field Observations ** _____

- * Attach a sketch showing a plan of structure and measurement locations.
- ** Place date and initials at the beginning of each entry.

END OF TIGHTNESS TEST REPORT FORM

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SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

1.2 SUMMARY

A. Section Includes:

- 1. General requirements for coordinating and scheduling commissioning activities.
- 2. Commissioning meetings.
- 3. Commissioning reports.
- 4. Use of commissioning process test equipment, instrumentation, and tools.
- 5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
- 6. Commissioning tests and commissioning test demonstration.
- 7. Adjusting, verifying, and documenting identified systems and assemblies.

B. Related Requirements:

- 1. Section CIP3 "Summary of Work" for Commissioning Authority responsibilities.
- 2. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
- 3. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
- 4. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.

1.3 DEFINITIONS

- A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- B. Basis-of-Design Document: A document prepared by Engineer that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.
- C. Commissioning Authority: An entity engaged by Owner, and identified in Section 011000 "Summary," to evaluate Commissioning-Process Work.

- D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.
 - E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities. The scope of the commissioning process is defined in CIP 3 "Summary of Work".
 - F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved. See Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
 - 1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:
 - a. Completion of tests and acceptance of test results.
 - b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
 - c. Comply with requirements in Section 017900 "Demonstration and Training."
 - d. Completion and acceptance of submittals and reports.
 - G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Engineer or Commissioning Authority.
 - H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Engineer-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.
 - I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
 - J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- 1.4 COMMISSIONING TEAM
- A. Members Appointed by Contractor(s):
 - 1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
 - 2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.

3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

B. Members Appointed by Owner:

1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
3. Engineer, plus employees and consultants that Engineer may deem appropriate for a particular portion of the commissioning process.

1.5 INFORMATIONAL SUBMITTALS

- A. Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.

B. Commissioning Plan Information:

1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
2. Schedule of commissioning activities, integrated with the Construction Schedule.
3. Contractor personnel and subcontractors participating in each test.
4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.

C. Commissioning schedule.

D. Two-week look-ahead schedules.

E. List test instrumentation, equipment, and monitoring devices. Include the following information:

1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
2. Brief description of intended use.
3. Calibration record showing the following:
 - a. Calibration agency, including name and contact information.
 - b. Last date of calibration.
 - c. Range of values for which calibration is valid.
 - d. Certification of accuracy.
 - e. Certification for calibration equipment traceable to NIST.
 - f. Due date of the next calibration.

F. Test Reports:

1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.
3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

G. Construction Checklists:

1. Material checks.
2. Installation checks.
3. Startup procedures, where required.

1.6 CLOSEOUT SUBMITTALS

A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:
 - a. Pre-startup reports.
 - b. Approved test procedures.
 - c. Test data forms, completed and signed.
 - d. Progress reports.
 - e. Commissioning issue report log.
 - f. Commissioning issue reports showing resolution of issues.
 - g. Correspondence or other documents related to resolution of issues.
 - h. Other reports required by commissioning process.
 - i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
 - j. Report shall include commissioning work of Contractor.

B. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Commissioning Coordinator Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.

- B. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:
 - 1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
 - 2. Calibrated and certified.
 - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
 - b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
 - 3. Maintain test equipment and instrumentation.
 - 4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

2.2 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.
 - 1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
 - 2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

2.3 REPORT FORMAT AND ORGANIZATION

- A. General Format and Organization:

1. Bind report in three-ring binders.
2. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.
3. Record report on compact disk.
4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

1. Include a table of contents and an index to each test.
2. Include major tabs for each Specification Section.
3. Include minor tabs for each test.
4. Within each minor tab, include the following:
 - a. Test specification.
 - b. Pre-startup reports.
 - c. Approved test procedures.
 - d. Test data forms, completed and signed.
 - e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review preliminary construction checklists and preliminary test procedures and data forms.

3.2 CONSTRUCTION CHECKLISTS

- A. Construction checklists cannot modify or conflict with the Contract Documents.
- B. Create construction checklists based on actual systems and equipment to be included in Project.
- C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
 1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
 2. Included optional features.
 3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
 4. Installation Checks:

- a. Location according to Drawings and approved Shop Drawings.
 - b. Configuration.
 - c. Compliance with manufacturers' written installation instructions.
 - d. Attachment to structure.
 - e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
 - f. Utility connections are of the correct characteristics, as applicable.
 - g. Correct labeling and identification.
 - h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
- D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.
- E. Performance Tests:
1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
 2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
 3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
 4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
 5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.
- F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify deferred construction checklists by number and title.
 2. Provide a target schedule for completion of deferred construction checklists.
 3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.
- G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify delayed construction checklist by construction checklist number and title.

2. Provide a target schedule for completion of delayed construction checklists.
3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

3.3 GENERAL EXECUTION REQUIREMENTS

- A. Schedule and coordinate commissioning process with the Construction Schedule.
- B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.
- C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
- D. Report test data and commissioning issue resolutions.
- E. Schedule personnel to participate in and perform Commissioning-Process Work.
- F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:
 1. Operating the equipment and systems they install during tests.
 2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

3.4 COMMISSIONING COORDINATOR RESPONSIBILITIES

- A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:
 1. Coordinate with subcontractors on their commissioning responsibilities and activities.
 2. Obtain, assemble, and submit commissioning documentation.
 3. Conduct periodic on-site commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."
 4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
 5. Review and comment on preliminary test procedures and data forms.
 6. Report inconsistencies and issues in system operations.
 7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
 8. Direct and coordinate test demonstrations.
 9. Coordinate witnessing of test demonstrations by Owner's witness.
 10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 017900 "Demonstration and Training."
 11. Prepare and submit specified commissioning reports.
 12. Track commissioning issues until resolution and retesting is successfully completed.

13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
14. Assemble and submit commissioning report.

3.5 COMMISSIONING TESTING

- A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.
- B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.
- C. Construction Checklists:
 1. Complete construction checklists as Work is completed.
 2. Distribute construction checklists to installing contractors before they start work.
 3. Installers:
 - a. Verify installation using approved construction checklists as Work proceeds.
 - b. Complete and sign construction checklists work performed during the preceding period.
 4. Provide Commissioning Authority access to construction checklists.
- D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.
- E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.
- F. Test Procedures and Test Data Forms:
 1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
 2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
 3. Completed test data forms are the official records of the test results.
 4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.

5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:
 - a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
 - b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.
6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."
7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100 percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least three days in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.
 - a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with

the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.

7. False load test requirements are specified in related sections.
 - a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Engineer's written approval.

I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:
 - a. Identify deferred tests by number and title.
 - b. Provide a target schedule for completion of deferred tests.
2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Engineer and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:
 - a. Identify delayed tests by test number and title.
 - b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.
2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Engineer and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Owner's witness. Schedule delayed tests to

minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:
 - a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
 - b. Submit commissioning compliance issue report form within 24 hours of the test.
 - c. Determine the cause of the failure.
 - d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.
 - a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.
 - b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
 - c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
 - d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.
6. Diagnose and correct failed test demonstrations as follows:
 - a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
 - b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
 - c. Record the results of each step of the diagnostic procedure.
 - d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
 - e. Determine and record corrective measures.

- f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.
7. Retest:
 - a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
 - b. For each repeated test demonstration, submit a new test data form, marked "Retest."
 8. Do not correct commissioning compliance issues during test demonstrations.
 - a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than five minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

3.6 SEQUENCING

- A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:
 1. Construction Checklists:
 - a. Material checks.
 - b. Installation checks.
 - c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
 - d. Performance Tests:
 - 1) Static tests, as appropriate.
 - 2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
 - 3) Equipment and assembly performance tests.
 - 4) System performance tests.
 - 5) Intersystem performance tests.
 2. Commissioning tests.

- B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.
- C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Engineer if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.
- D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

3.7 SCHEDULING

- A. Commence commissioning process as early in the construction period as possible.
- B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule.
 - 1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
 - 2. Schedule the start date and duration for the following commissioning activities:
 - a. Submittals.
 - b. Preliminary operation and maintenance manual submittals.
 - c. Installation checks.
 - d. Startup, where required.
 - e. Performance tests.
 - f. Performance test demonstrations.
 - g. Commissioning tests.
 - h. Commissioning test demonstrations.
 - 3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
 - 4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.
- C. Two-Week Look-Ahead Commissioning Schedule:
 - 1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
 - 2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
 - 3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.
- D. Owner's Witness Coordination:

1. Coordinate Owner's witness participation via Engineer.
2. Notify Engineer of commissioning schedule changes at least two work days in advance for activities requiring the participation of Owner's witness.

3.8 COMMISSIONING REPORTS

A. Test Reports:

1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:
 - a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
 - b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
 - c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
 - d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
 - e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.
2. Test data reports include the following:
 - a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
 - b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
 - c. Signatures of individuals performing and witnessing tests.
 - d. Data trend logs accumulated overnight from the previous day of testing.
3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:
 - a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.

- b. Action distribution list.
 - c. Report date.
 - d. Test number and description.
 - e. Equipment identification and location.
 - f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
 - g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
 - h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
 - i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
 - j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
 - k. Schedule for retesting.
4. Weekly progress reports include information for tests conducted since the preceding report and the following:
 - a. Completed data forms.
 - b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
 - c. Activities scheduled but not conducted per schedule.
 - d. Commissioning compliance issue report log.
 - e. Schedule changes for remaining Commissioning-Process Work, if any.
5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.
 - a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
 - b. Attach to the data form printed trend log data collected during the test or test demonstration.
 - c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.
6. System Alarm Logs: Record and print out log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."
 - a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

3.9 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

- A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Engineer a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to complete commissioning process.
- B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.
- C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Engineer's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.
- D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

END OF SECTION 019113

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SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
- 2. Demolition and removal of selected site elements.
- 3. Salvage of existing items to be reused or recycled.

- B. Related Requirements:

- 1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
- 2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
- 3. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove Hazardous Materials: Isolate and remove hazardous materials from existing construction and properly dispose as required by existing regulations.
- C. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and discuss with Owner for reuse or storage.
- D. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- E. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- F. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection. Indicate proposed locations and construction of barriers.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.

- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 4 hours after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

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SECTION 025731 - KARST VOID MITIGATION

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. Notification requirements.
 - 2. Mitigation measures for significant voids and water flow features discovered in bedrock during excavation activities.
- B. Related Requirements:
 - 1. Pipe excavation, trenching, embedment, encasement and backfilling are included in Section G4.
 - 2. Granular fill materials are included in Section G5.
 - 3. Sedimentation and erosion control are included in Section G6.
 - 4. Submittals are included in Section 013300.
 - 5. Trench Safety Requirements are included in Section CIP11.
 - 6. Concrete for structures is included in Section C2.
 - 7. Flowable backfill is included in Section C9.

1.3 DEFINITIONS

- A. Void Type Grade 1: Opening in rock measuring more than 1 cubic foot (e.g., 1 foot by 1 foot by 1 foot), but less than 18 cubic feet (e.g., 2 feet by 3 feet by 3 feet).
- B. Void Type Grade 2: Opening in rock measuring 18 cubic feet or more but less than 160 cubic feet (e.g., 4 feet by 4 feet by 10 feet or 2 feet by 2 feet by 20 feet).
- C. Void Type Grade 3: Opening in rock measuring 160 cubic feet or more . A specifically designed mitigation measure will typically be required for this size void.
- D. Local Regulatory Authority: The Texas Commission on Environmental Quality.
- E. Geologist: A licensed Professional Geologist, registered in the State of Texas, hired by either the Engineer or Contractor.
- F. Qualified Geophysical Testing Firm: A firm with a Professional Geologist licensed in the State of Texas with a minimum of 5 years of experience performing geophysical testing, including ground penetrating radar (GPR) and other applicable test methods to identify potential

subsurface voids. When required, this firm will be hired by the Contractor and is to provide independent site evaluation.

1.4 UNIT PRICES

- A. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.
1. 24 inches outside of concrete forms other than at footings.
 2. 12 inches outside of concrete forms at footings.
 3. 6 inches outside of minimum required dimensions of concrete cast against grade.
 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 5. 24 inches beneath bottom of concrete slabs-on-grade.
 6. 12 inches beneath pipe in trenches, and greater of 24 inches wider than pipe or 42 inches wide.
- B. Void Mitigation:
1. Description: Includes replacement with approved materials, including all labor, materials, equipment and all appurtenances.
 2. Unit of Measurement: By cubic yard.
- C. Excavation:
1. Description: Includes authorized additional excavation.
 2. Unit of Measurement: By cubic yard.
- D. Hard Rock:
1. Description: Includes hard rock.
 2. Unit of Measurement: By cubic yard.
- E. Concrete:
1. Description: Includes concrete for plugging.
 2. Unit of Measurement: By cubic yard.
- F. Grout:
1. Description: Includes grout for plugging.
 2. Unit of Measurement: By cubic yard.
- G. Geotextile Fabric:
1. Description: Includes geotextile fabric.
 2. Unit of Measurement: By square yard.
- H. Permanent Turf Reinforcement Mat (PTRM):

1. Description: Includes permanent turf reinforcement mat.
2. Unit of Measurement: By square yard.

I. Rock-Filled Polypropylene Bags:

1. Description: Includes bags and sand/rock fill.
2. Unit of Measurement: By cubic yard.

1.5 INSTALLATION CONFERENCE

- A. In-field Conference: Conduct in-field conference at void location with Owner's Representative, Engineer and Engineer's Geologist, prior to proceeding with mitigation.

1.6 ACTION SUBMITTALS

- A. Material Data and Certification: For each type of material to be used. Submit prior to start of construction to avoid delay in the event a void is encountered.

1. Flowable backfill.
2. Concrete.
3. Hard Rock.
4. Filter fabric.
5. Permanent turf reinforcement mat.
6. Polypropylene bags filled with pea gravel.
7. Other materials as specified herein and shown on the Drawings.

- B. Shop Drawings: Provided by the qualified licensed consulting Geologist registered in the State of Texas.

1. Include plans, sections, and requirements for furnishing and installing mitigation measures significant voids and water flow features discovered in bedrock during excavation activities of a project.
2. Provide field sketches and photographs documenting any void mitigation measures installed during construction.
3. Pipe wall crushing and deflection calculations, as appropriate for flowable fill backfill associated with Class III Void Mitigation Measures.

1.7 CLOSEOUT SUBMITTALS

- A. Project Closeout: For project closeout submittal, refer to Section CIP 14 Project Closeout.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1021 for testing indicated.
- B. Testing Agency Qualifications: Member company of ANSI/NETA or Nationally Recognized Testing Laboratory (NRTL).

1.9 SITE CONDITIONS

- A. Visit site of work and examine premises to verify existing conditions relative to work.
- B. Notify Engineer and Owner in writing within 24 hours of a discovered void that meets any of the following criteria:
 - 1. Is at least one square foot in total area.
 - 2. Blows air from within substrate.
 - 3. Consistently receives water during any rain event.
 - 4. Potentially transmits groundwater.
- C. Discontinue construction within 50 feet of void extents until mitigation measures are reviewed and approved by Owner and Engineer.
 - 1. Construction may only proceed after mitigation measures are reviewed and approved by the Engineer, Owner and Local Regulatory Authority, if applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Hard Rock:
 - 1. Hardness: Greater than 7 on the Mohs hardness scale.
 - 2. Size: 3 inches in smallest dimension and 5 inches in largest dimension.
 - 3. Open-graded with details and fines removed.
 - 4. Durable, sound material not susceptible to degradation due to presence of water.
- B. Controlled Low Strength Material (Flowable Fill):
 - 1. Meet requirements for flowable fill included in Section C9.
- C. Low Slump Concrete:
 - 1. Meet requirements for curb and gutter, hand-vibrated concrete as specified in Section C1.
 - a. Maximum 3-inch slump.
 - b. 3,500 psi concrete mixtures allowed or required by the Local Regulatory Authority that meet the same specification will be accepted as an alternate on a case-by-case basis.
- D. Pea Gravel:
 - 1. Meet requirements of pea gravel backfill included in Section G5.
- E. Pipe:
 - 1. All pipe used for Air and Moisture continuity shall comply with ASTM D1785 schedule 40 PVC.

2.2 GEOTEXTILES

A. Filter Fabric:

1. Meet requirements for silt fence fabric filter fabric included in Section G6.

B. Polypropylene Bags for Pea Gravel:

1. Description:

- a. Non-biodegradable, UV-resistant, woven geotextile fabric.
- b. Material: Polyester Polypropylene or Polyethylene.
- c. Edges: Selvaged or finished to prevent separation of outer material.
- d. Calendar such that yarns will retain relative positions.
- e. Tied to be fully enclosed to prevent loss of internal material.

2. Performance Criteria:

- a. Minimum Bag Size: 14 inches wide by 24 inches long and 6 inches thick when filled.
- b. Nominal Weight Capacity: 50 lb.
- c. Minimum Fabric Denier: 1250.
- d. Minimum UV Rating: 4,000 hours.

C. Permanent Turf Reinforcement Mat (PTRM):

1. Non-Degradable Turf Reinforcement Mat: Meet specification requirements of United States Department of Transportation, Federal Highway Administration (FHWA) FP-03, Section 713.18.
2. Material: Nylon or other inert plastic not coated with chemical, substance or film.
3. Mesh Opening: Maximum 0.1 inch.

2.3 ACCESSORIES

- A. Use products to tie and secure geotextile fabrics as recommended by geotextile manufacturer to prevent loss of internal material or movement of geotextile during performance of the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. At least 72 hours before completing each of the structure excavations listed in Section 312000 "Earthwork" to the prescribed elevations, depths and extents shown on the Drawings or specified for the Work, notify Contractor's independent geophysical testing firm when required to perform geophysical evaluation of the completed excavation. Submit geophysical results and interpretation of potential voids to Engineer as required prior to beginning backfilling.
- B. Upon notification of a void meeting conditions for mitigation, Owner will direct Engineer to establish appropriate permanent void and water flow mitigation measures. Engineer will arrange

for an inspection of the void by a qualified licensed consulting Geologist registered in the State of Texas and hired by the Engineer.

- C. If Engineer, Engineer's consulting Geologist or designated representative observes unusually large voids or unforeseen circumstances, other measures may be prescribed than those in this Section.

3.2 MITIGATION MEASURES

- A. Class I Void Mitigation Measures: Temporary measures for a void at bottom of an excavation/trench or along a side wall of an excavation/trench.
 - 1. Cover void opening with filter fabric.
 - a. Minimum 3-foot distance from edge of void to edge of filter fabric.
 - 2. Then cover void opening with plywood planking.
 - a. Minimum 1-foot distance from edge of void to edge of planking. Planking is to be placed to prevent backfill from entering void.
 - 3. Finally, place rock or concrete block over planking to keep planking secured.
 - a. Minimum weight of 5 pounds.
- B. Class II Void Mitigation Measures: Permanent measures for a void at bottom of an excavation/trench.
 - 1. For void openings greater than 30-inches deep, Engineer will provide direction to either hand pack 3 to 5-inch hard rock to provide stable bearing support and cover rock at opening with filter fabric or backfill entire void with low slump concrete (3,500 psi).
 - 2. If 3 to 5-inch hard rock used, place low slump concrete (3,500 psi) to cover opening area and seal void at limits of excavation.
 - a. Concrete: Minimum 18 inches thick within void opening extending minimum of 6 inches beyond edge of void.
 - b. Seal void openings less than 30 inches deep entirely with concrete. Use form to ensure proper placement of a low slump concrete-seal.
 - c. After void is covered, place flowable fill as bedding and backfill extending a minimum of 5 feet beyond edge of all voids in all directions.
 - 3. For Class II voids, additional measures may be specified by Engineer, Engineer's consulting Geologist or Local Regulatory Agency representative (e.g., increase thickness of concrete and placement of rebar reinforcement in concrete, placement of a steel plate over void opening, etc.).
- C. Class III Void Mitigation Measures: Permanent measures in wall of an excavation/trench.
 - 1. Hand pack 3 to 5-inch hard rock to provide stable bearing support and cover rock at opening with filter fabric.

2. Hand pack void area with pea gravel-filled sealed polypropylene bags to provide stable bearing support to protect a void from infiltration of backfill material.
 3. If a void is greater than 100 cubic feet or is located within a rock stratum that is structurally unstable, as determined by the Engineer or Engineer's consulting Geologist, use 3 to 5-inch hard rock behind gravel-filled polypropylene bags to prevent ground collapse.
 4. As required by Engineer, Engineer's consulting Geologist or Local Regulatory Authority representative, connector pipes may be required to maintain air or water flow within a void bisected by excavation/trench.
 5. After a void is filled, place low slump concrete (3,500 psi) to seal void opening. If needed, place a form to ensure a minimum thickness of concrete extends at least 18 inches into void.
 6. In trenches, provide secondary containment of wastewater and storm sewer lines by outer carrier pipe or low slump concrete (3,500 psi) or flowable fill encasement.
 - a. Design of carrier pipe must be reviewed by Engineer for all wastewater and storm sewer lines prior to approval of the mitigation plan by the Local Regulatory Authority. Provide stabilizing collars and other supports.
 - b. Low Slump Concrete or Flowable Fill Encasement: Minimum 6-inch thickness on all sides of pipe extending minimum of 5 feet beyond edge of any voids.
 - c. If flowable fill encasement is proposed, submit pipe deflection and wall crushing calculations.
- D. Class IV Void Mitigation Measures: Will not be used for this project.
- E. Class V Void Mitigation Measures: Permanent measures for a void which extends through excavation/trench and contains actively flowing water.
1. Place Low Slump Concrete or Flowable Fill material into excavation or along pipe length as directed by Engineer or designated representative.
 2. Place pea-gravel backfill material wrapped in PTRM one foot beyond limits of void in all directions. Place PTRM along areas between gravel material and trench walls/earth backfill overlapping at top.
 3. Place minimum 3 feet of Low Slump Concrete or Flowable Fill into excavation or along pipe length on either side of gravel backfill material extending minimum of 1 foot above gravel backfill material. Use forms to control placement of concrete or flowable backfill material.
- F. For very large voids, Engineer's Geologist will conduct a cave stability analysis and define specific mitigation measures. Implement specific mitigation measures per direction of Engineer or designated representative after the mitigation plan is approved by the Local Regulatory Authority.

3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Engineer will engage a qualified licensed Geologist to perform the following inspections.
1. Geologic and biologic inspection for temporary void protection.
 2. Second void or water flow feature inspection.

3. Once daily inspections during excavation operations and prior to backfilling excavation/trench.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

END OF SECTION 02 57 31

SECTION 030130.71 - MODIFICATIONS TO EXISTING 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. Cutting, removing, or modifying parts of existing concrete structures or appurtenances.
- 2. Addressing existing steel reinforcing bars encountered.
- 3. Bonding new concrete or grout to existing concrete.

- B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for formwork and related repair work.
- 2. Section 032000 "Concrete Reinforcing" for reinforcing and related repair work.
- 3. Section 033000 "Cast-In-Place Concrete" for concrete materials, and related work.
- 4. Section 031500 "Concrete Joints and Accessories" for related work.
- 5. Section 033500 "Concrete Finishing" for related work.
- 6. Section 033900 "Concrete Curing" for related work.
- 7. Section 036000 "Grouting" for grout and related accessories.
- 8. Section 050519 "Post-Installed Anchors" for anchors and related accessories.
- 9. Section 051200 "Structural Steel Framing" for related work.
- 10. Section 055000 "Metal Fabrications" for various metals and related fabrications.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review methods and procedures related to modifications to existing concrete including, but not limited to, the following:
 - a. Verify specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.
 - d. Coordination with building occupants.
- 2. Attendees:
 - a. Owner.

- b. Resident Engineer.
- c. Contractor.
- d. Engineer.
- e. Manufacturer Representative.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Submit manufacturer's technical literature and installation instructions that include:
 - a. Current printed recommendations and product data sheets for products including performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, volatile organic compound data, and safety requirements.
 - b. Storage requirements including temperature, humidity, and ventilation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Documentation of the qualifications for Contractor qualifications, Manufacturer's qualifications, and Contractor's supervisor as specified in Part 1 "Quality Assurance" Article.

B. Material Certificates: For each material provided.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Have a minimum of ten years' experience within last 10 years in manufacture and use of specified products and have an ongoing program of training, certifying, and technically supporting Contractor's personnel.
- B. Contractor Qualifications: Complete a program of instruction in application of approved manufacturer's material and provide certification from manufacturer attesting to their training and status as an approved applicator.
- C. Contractor's Supervisor: Have attended a training program sponsored by manufacturer supplying materials approved for this project.
- D. Manufacturer's Representative: A representative of product manufacturer who will visit the site for first three days of installation to give instructions to installation crew. Make periodic site visits to ensure products being installed are in accordance with published instructions.
- E. Be solely responsible for workmanship and quality of modification work. Inspections by the manufacturer, Engineer, or others do not limit Contractor's responsibility for work quality.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in original, new, and unopened packages and containers clearly labeled with the following information:
 - 1. Manufacturer's name.
 - 2. Name or title of material, and other product identification.
 - 3. Manufacturer's stock number and batch number.
 - 4. Date of manufacture.
 - 5. Instructions.
 - 6. Expiration date.

- B. Storage: Store products in accordance with manufacturers' published recommendations and the following supplementary requirements:
 - 1. Store only approved materials on site and in locations as directed.
 - 2. Keep area clean and accessible.
 - 3. Comply with health and fire regulations including those of the Occupational Safety and Health Administration (OSHA).

- C. Handling: Handle products carefully and in accordance with manufacturers' published recommendations and the following supplementary requirements:
 - 1. Prevent inclusion of foreign materials.
 - 2. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with this Section and applicable state and local regulations.

- B. Epoxy Bonding Agent:
 - 1. Product: Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C881, Type V, Grade 2, Class C.

- C. Epoxy Paste Adhesive:
 - 1. Product: Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C881, Type IV, Grade 3, Class C.

- D. Repair Mortar (Polymer-Modified Portland Cement Mortar):
 - 1. Horizontal Surfaces:
 - a. Product: Two-component polymer-modified, portland cement-based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a

minimum compressive strength of 7,000 psi at 28 days tested in accordance with ASTM C881 or ASTM C109.

2. Vertical and Overhead Surfaces:
 - a. Product: Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psi at 28 days tested in accordance with ASTM C881 or ASTM C109.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which modification work is to be installed, and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- B. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION - GENERAL

- A. Do not shift, cut, remove, or otherwise altered existing structure or concrete until authorization is given by Engineer.
- B. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.
- C. Unless otherwise permitted, shown, or specified, cut existing concrete by line drilling.
- D. Construction Tolerances: Comply with requirements specified elsewhere in Division 03, except as modified herein, and elsewhere in Contract Documents.
- E. Make locations and phases of the work available for access by Engineer or other personnel designated by Engineer. Provide ventilation and safe access to the work.
- F. Cut, remove, or otherwise modify parts of existing structures or appurtenances as indicated, specified, or as necessary to complete the work. Finishes, joints, reinforcements, sealants, and similar materials are specified in their respective Sections. Install work complying with requirements of this Section and as indicated.
- G. Locations, details, and limits of modifications are indicated on Drawings. Comply with requirements of this Section and as indicated on Drawings.

- H. Examine areas and conditions under which modification work is to be installed, and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- I. Store, mix, apply, and cure materials in strict compliance with manufacturer's instructions.
- J. Where concrete is to be modified near an expansion joint or control joint, preserve isolation between components on either side of the joint.
- K. When drilling holes for dowels and bolts, stop drilling if reinforcing is encountered. Do not cut reinforcing without prior approval by Engineer. Relocate hole to avoid reinforcing as approved by Engineer.
 - 1. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference.
- L. Saw-cut edges for modification areas vertically and horizontally straight. Make intersecting cuts perpendicular to each other.
- M. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by Engineer. Identify reinforcing locations within 1 foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.
- N. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by sandblasting, oil-free air-blasting, scarifying, or other mechanical means to sound original concrete.
- O. Consolidate modification materials, completely filling portions of the area to be filled.
- P. Bring finished surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture including any coatings or surface treatments that had been provided for the existing structure.
- Q. Repair or replace concrete indicated or specified to be left in place that is damaged because of the work by approved means without additional compensation.

3.3 CONCRETE REMOVAL

- A. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.
- B. Concrete designated to be removed to specific limits indicated or directed by Engineer, perform saw cutting 1 inch deep at limits of removal followed by line drilling and chipping, sandblasting, or oil-free air blasting, as appropriate in the areas where concrete is to be taken out. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.

1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, herein specified, or after obtaining written approval from Engineer.
- C. Where existing reinforcing is exposed due to cutting or line drilling and no new material is to be placed on cut surface, apply a 1/4 inch thick surface treatment of epoxy paste to entire cut surface.
- D. Where joint between new concrete or grout and existing concrete will be exposed in finished work, remove concrete edge by making a 1 inch deep saw cut on each exposed surface of existing concrete or as indicated.

3.4 CONNECTION SURFACE PREPARATION

- A. Concrete areas requiring patching, repairs, or modifications, prepare connection surfaces as specified, as indicated, or as directed by Engineer.
- B. Remove loose and deteriorated materials, efflorescence, existing repair materials, dirt, oil, grease, and other bond inhibiting materials from concrete surface by dry mechanical means such as sandblasting, chipping, wire brushing, or other mechanical means as approved by Engineer.
 1. Uniformly roughen concrete surface to approximately 1/4 inch amplitude with pointed chipping tools. Thoroughly clean surface of loose or weakened material by sandblasting or air-blasting.
 2. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.
- C. If reinforcing steel is exposed, mechanically clean to remove loose material, contaminants, and rust as approved by Engineer. If half of reinforcing steel diameter is exposed, chip out behind the steel. Chip distance behind the steel to a minimum of 1 inch. Do not damage reinforcing to be incorporated in new concrete or repair mortar during removal operation.
- D. Clean reinforcing from existing removed or deteriorated concrete that is shown to be incorporated in new concrete or repair mortar by mechanical means to remove loose material and products of corrosion before proceeding. Cut, bend, or lap to new reinforcing as indicated and provide with 1 inch minimum clear cover.
- E. Use following specific concrete surface preparation Methods where indicated, specified, or as directed by Engineer:
 1. Method A:
 - a. Roughen and clean existing concrete surface at connection.
 - b. Thoroughly saturate surfaces with water; prevent standing water during application.
 - c. Scrub repair mortar into substrate filling concrete pores and voids.
 - d. While scrub coat is still plastic, force repair material against surface. Use epoxy bonding agent if area is too large.
 - e. Place new repair mortar as detailed.
 2. Method B:

- a. Roughen and clean existing concrete surface at connection.
- b. Apply epoxy bonding agent at connection surfaces.
- c. Place new concrete or grout mixture to limits indicated within time constraints recommended by manufacturer to ensure bond.

3. Method C:

- a. Use adhesive anchoring system, as specified in Section 050519 “Post-Installed Anchors and Reinforcing Bars”, for installation of reinforcing steel dowels into existing concrete where indicated.
- b. Perform installation complying strictly with manufacturer's recommendations, including drill bit diameter, surface preparation, injection, and installation of dowels.
- c. Drill concrete to embedded deformed bars to indicated depths.
- d. Use oil-free compressed air to blast out loose particles and dust from drilled holes. Clean dowels to be free of dirt, oil, grease, ice, or other deleterious material that would reduce bond.
- e. Concrete in existing structures is considered to have a strength of 3,000 psi.

4. Method D:

- a. Combination of Method B & Method C.

3.5 GROUTING

- A. Grout: As specified in Section 036000 “Grouting.”

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed installations.
 1. Perform inspection with Contractor, material installer, and Engineer present. Give minimum of 72 hours’ notice prior to time of inspection.
 2. Repair modifications not in conformance with Contract Documents in accordance with manufacturer's instructions at no additional cost to Owner.
 3. At completion of non-conforming repairs, Contractor, material installer, and Engineer shall reinspect the repaired problem areas.
 4. Prepare inspection reports, identifying acceptable work, type and locations of unacceptable work, and actions taken to correct unacceptable work.
 5. Complete field quality control work without additional compensation.

END OF SECTION 030130.71

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SECTION 031000 - 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. Formwork for cast-in-place concrete.
2. Shoring, bracing, and anchorage.
3. Architectural form liners.
4. Form accessories.
5. Form stripping.
6. Delegated Design.

- B. Related Requirements:

1. Section 032000 "Concrete Reinforcing" for reinforcing steel and required supports for cast-in-place concrete.
2. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete.
3. Section 033500 "Concrete Finishing."
4. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for testing of drilled in injection adhesive anchor system.
5. Section 055000 "Metal Fabrications" for product requirements for metal fabrications for placement by this Section.
6. Various Sections in Division 07: Product requirements for flashing reglets for placement by this Section.
7. Various Sections in Divisions 22 and 23 for product requirements for plumbing and HVAC items for placement by this Section.
8. Various Sections in Divisions 26 for product requirements for electrical items for placement by this Section.

1.3 DEFINITIONS

- A. Structural Concrete: Concrete that is not architectural concrete.

1.4 COORDINATION

- A. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.5 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information on void form materials and installation requirements.
- B. Shop Drawings:
 - 1. Indicate:
 - a. Formwork, shoring, and reshoring.
 - b. Pertinent dimensions, openings, details of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding, and bracing, and temporary supports.
 - c. Means of leakage prevention for concrete exposed to view in finished construction.
 - d. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.
 - e. Procedure and schedule for removal of shores and installation and removal of reshores.
 - f. Location and sequence of concrete placement.
 - g. Form release agent.
 - h. Form ties.
- C. Review of submittals will be for appearance, performance, and strength of completed structure only. Approval by Engineer will not relieve Contractor of responsibility for the strength, safety, or correctness of methods used, the adequacy of equipment, or from carrying out the work as shown on Contract Documents.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for formwork shoring, and reshores.
 - 2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.
 - 3. Include signed and sealed structural calculations to support design for project records. Calculations will not be reviewed.
- B. Delegated Design Structural Design Responsibility: Provide forms, shoring, and reshoring designed by a professional engineer registered in the State of Texas. Design formwork in accordance with the requirements of ACI 301, ACI 318 and ACI 347. Comply with all applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

1.7 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

C. Qualifications Statement:

1. Submit qualifications for licensed professional.

D. Certify form release agent is made for use in contact with potable water (non-toxic and free of taste and odor after 30 days). Certify that form release agent complies with Federal, State, and local VOC limitations.

E. Test Reports:

1. Compressive testing of degradable void forms – submit testing data for time-dependent compressive strength loss of degradable void forms exposed to a moist environment.

1.8 QUALITY ASSURANCE

A. Perform Work according to ACI 347, 301, and 318.

B. For wood products furnished for Work of this Section, comply with AF&PA.

C. Form liner manufacturer's representative: Be on-site during the initial installation of the form liner to instruct the Contractor on the proper methods of application and use of the liner. Be available to answer any questions on the liner that the Engineer may have.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of the Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Degradable Void Forms and Materials:

1. Inspection: Accept degradable void forms on Site in manufacturer's original packaging and inspect for damage.
2. Store in full compliance with the manufacturer's recommendations.
3. Protect from the elements, wetting, moisture and dampness. Store in an elevated area off the ground under ventilated weathertight cover or in ventilated weathertight enclosures.
4. Do not use material that has become wet, damp, or otherwise damaged. Remove immediately from the site material which becomes wet, damp, or otherwise damaged and replace with new undamaged material at no additional cost to the Owner.

B. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design formwork shoring, and reshores.

- B. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318 ACI 347, ACI 347.2R, conforming to Texas Building Code requirements to achieve concrete shapes, lines, and dimensions as indicated and required by project conditions.
- C. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96, desiccant or water method.

2.2 FORMS, GENERAL

- A. Make forms for cast-in-place concrete of wood, steel, or other approved materials. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 033500 "Concrete Finishing."
 - 1. Construct wood forms of sound lumber or plywood free from knotholes and loose knots.
 - 2. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.
- B. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand high hydraulic pressures resulting from rapid filling of forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern or as indicated on Drawings.
- C. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, or caulk joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.
- D. Provide 3/4 inch chamfer on form corners unless otherwise indicated.

2.3 FORMS FOR STRUCTURAL CONCRETE

- A. Plywood Forms:
 - 1. Make forms for exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels.
 - 2. Species: Douglas fir or Spruce.
 - 3. Grade: B grader or better.
 - 4. Edges: Clean and true.
 - 5. Exposed Concrete:
 - a. Comply with APA/EWA PS 1.
 - b. Panels: Full size, 4 by 8 feet.
 - c. Label each panel with grade trademark of APA/EWA
 - 6. Surfaces to Receive Membrane Waterproofing:
 - a. Minimum Thickness: 5/8 inch.
 - b. Grade: APA/EWA "B-B Plyform Structural I Exterior."
 - 7. "Smooth Finish" Indicated on Drawings:

- a. Minimum Thickness: 3/4 inch.
 - b. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."
8. Design and construct forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing, except as specified in Section 033500 "Concrete Finishing."
- B. Lumber Forms:
1. Applications: Edge forms and unexposed finish concrete.
 2. Description:
 - a. Shiplapped or tongue and groove.
 - b. Surface boards on four sides.
 3. Material: Standard grade, Douglas fir according to WCLIB Standard No. 17.
 4. Width: 6 inches or 8 inches.
- C. Preformed Steel Forms:
1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 2. Minimum Thickness: 16 gage.
- D. FRP Forms: Matched, tightly fitted, and stiffened to support weight and pressure of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- E. Pan Forms:
1. Material: Steel.
 2. Configuration: Size and profile as required.
- F. Tubular Column Forms:
1. Description: Round spirally wound laminated fiber or wood.
 2. Provide forms for circular structures that conform to circular shape of structure and where applicable the existing structure below. Straight panels may be substituted for circular panels if straight panels do not exceed two feet in width, deflect more than 3-1/2 degrees per joint, or conflict with specific notes indicated and panels conform with the existing structure below.
- G. Void Forms:
1. Moisture-resistant treated paper faces; biodegradable.
 2. Structurally sufficient to support weight of wet concrete and construction loads until concrete has attained specified design strength.
 3. Thickness: 2 inches or 4 inches.
- H. Steel Forms: Description: Sheet steel, suitably reinforced.
- I. Smooth Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.

- J. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.

2.4 COATINGS

A. Coatings for Aluminum:

1. Polyamide epoxy finish coat with paint manufacturer's recommended primer for aluminum substrate.
2. One coat primer and one coat finish.

2.5 FORMWORK ACCESSORIES

A. Form Ties:

1. Type: Removable snap off; cone.
2. Material: Galvanized, carbon steel, or stainless steel.
3. Length: Adjustable.
4. Furnish waterproofing washer.
5. Free of defects capable of leaving holes larger than 1 inch in concrete surface.
6. Coil and Wire Ties: Provide ties manufactured so that after removal of projecting part, no metal remains within 1-1/2 inch of concrete face. The part of the tie to be removed shall be at least 1/2-inch diameter or be provided with a plastic or wooden cone at least 1/2 inch 1/2-inch diameter and 1-1/2 inch long. Provide cone washer type form ties in concrete exposed to view.
7. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2 inch and manufactured to permit patching of the tie hole.
8. Provide ties for liquid retaining structures and exterior below grade basement walls that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.
9. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of same minimum size may be used. Install in forms so that large end is, where applicable, on liquid or backfilled side of the wall. Clean, fill, and seal form tie hole with rubber plug installed from the liquid or backfilled side and non-shrink cement grout to provide watertight form tie holes. Make repairs needed to make watertight.
10. Alternate form ties specified in Paragraph above may be used when forms are to be set against previously placed or existing concrete walls. Use in conjunction with cast-in threaded inserts or drilled-in threaded anchors so that no metal remains within expansion joint upon removal of tapered through bolt. Conform to requirements specified in above Paragraph.

B. Spreaders:

1. Description: Standard, non-corrosive, metal-form clamp assembly of type acting as spreaders and leaving no metal within 1 inch of concrete face.
2. Wire ties, wood spreaders, or through bolts are not permitted.

C. Form Release Agent:

1. Description: Colorless mineral oil or form coating that will not stain concrete or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.
2. Form Release Agent. Coat form surfaces in contact with concrete with an effective, non-staining, non-residual, water based, bond-breaking form coating, unless otherwise indicated or specified. Use form release agent made for use in contact with potable water, non-toxic and free of taste and odor after 30 days. Form release agent shall not impair the bond of paint, sealant, waterproofing, dampproofing, or other coatings.
3. For concrete surfaces which are to be painted, use forms with high density overlay or a similar material which does not require a form release agent unless Contractor can substantiate to satisfaction of Engineer that form release agent will not remain on formed surface after it is stripped.

D. Bond Breaker:

1. Bond breakers for precast and tilt-up construction when cast against concrete shall be a non-staining, non-residual type, which will provide a positive bond prevention.
2. Acceptable Manufacturers: One of the following or equal:
 - a. Dayton Superior Specialty Chemical Corporation: Sure-Lift (J-6).
 - b. Universal Form Clamp Co: Super Clean and Tilt.
 - c. Nox-Crete Products Group: Silcoseal Select.

E. Corners, Recesses for Joint Sealant, Rustications, and Drip Edges:

1. Type: Fillet,.
2. Provide rustications as indicated. Mill and plane smooth moldings for chamfers and rustications. Provide rustications and chamfer strips of nonabsorbent material, compatible with the form surface and fully sealed on all sides to prevent the loss of paste or water between the two surfaces.
3. Size: 3 inches on all sides.
4. Lengths: Maximum possible.

F. Dovetail Anchor Slot:

1. Material: Galvanized steel.
2. Thickness: 22 gage.
3. Filling: None.
4. Fasten slot to concrete formwork according to manufacturer instructions and insert foam filler to prevent concrete from entering slot during pour.

G. Flashing Reglets:

1. Material: Galvanized steel or Rigid PVC.
2. Thickness: 22 gage.
3. Lengths: Maximum possible.
4. Furnish alignment splines for joints.
5. Filling: None.
6. Fasten flashing reglet to concrete formwork according to manufacturer instructions, and insert foam to prevent concrete from entering reglet during pour.

- H. Vapor Retarder:
 - 1. Description: Polyethylene sheet.
 - 2. Thickness: 8 mils.
- I. Nails, Spikes, Lag Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with formwork.
- B. Verify that dimensions agree with Shop Drawings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Earth Forms: Not permitted.
- B. Formwork:
 - 1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
 - 2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
 - 3. Camber forms where necessary to produce level finished soffits unless indicated otherwise on Drawings.
 - 4. Positioning:
 - a. Carefully verify horizontal and vertical positions of forms.
 - b. Correct misaligned or misplaced forms before placing concrete.
 - 5. Complete wedging and bracing before placing concrete.
 - 6. Erect formwork, shoring, and bracing according to ACI 301, ACI 318. and ACI 347.
 - 7. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.
 - 8. Install fillet and chamfer strips for corners, recesses for sealant, rustications, and drip edges on external exposed corners of beams, joists, columns, and walls.
 - 9. Install void forms according to manufacturer instructions.
 - 10. Form Release Agent:
 - a. Apply according to manufacturer instructions.
 - b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

- c. Do not apply form release agent if concrete surfaces are indicated to receive special finishes or applied coverings that may be affected by agent.
 - d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.
 - e. Apply form coatings before placing reinforcing steel.
11. Leave forms in place for minimum number of days according to ACI 347.
 12. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and until the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces.
 13. Do not remove shores until concrete has attained at least 70 percent of its specified design strength and also sufficient to support safely its own weight and the construction live load on it.
 14. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
 15. Stripping:
 - a. Arrange and assemble formwork to permit dismantling and stripping.
 - b. Do not damage concrete during stripping.
 - c. Permit removal of remaining principal shores.
 16. Be responsible for damage resulting from removal of forms and make repairs at no additional compensation. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to requirements for form removal specified in Section 033000 "Cast-in-Place Concrete."
 17. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.
 18. Discard damaged forms.
 19. Reuse and Coating of Forms:
 - a. Thoroughly clean forms and reapply form coating before each reuse.
 - b. For exposed Work, do not reuse forms with damaged faces or edges.
 - c. Apply form coating to forms according to manufacturer instructions.
 - d. Do not coat forms for concrete indicated to receive "scored finish."
 20. Do not reuse wood formwork more than two times for concrete surfaces to be exposed to view.
 21. Do not patch formwork.
 22. Form Cleaning:
 - a. Clean forms as erection proceeds to remove foreign matter within forms.
 - b. Clean formed cavities of debris prior to placing concrete.
 - c. Flush with water or use compressed air to remove remaining foreign matter.
 - d. Ensure that water and debris drain to exterior through cleanout ports.
 - e. Cold Weather:
 - 1) During cold weather, remove ice and snow from within forms.
 - 2) Do not use de-icing salts.

- 3) Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure; use compressed air or other dry method to remove foreign matter.

C. Forms for Smooth Finish Concrete:

1. Use steel, plywood, or lined-board forms.
2. Use clean and smooth plywood and smooth sheet form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
3. Install smooth sheet form lining with close-fitting square joints between separate sheets without springing into place.
4. Use full-sized sheets of smooth sheet form liners and plywood wherever possible.
5. Tape joints to prevent protrusions in concrete.
6. Apply forming and strip wood forms in a manner to protect corners and edges.
7. Level and continue horizontal joints.

D. Forms for Surfaces to Receive Membrane Waterproofing:

1. Use plywood or steel forms.
2. After erection of forms, tape form joints to prevent protrusions in concrete.

E. Framing, Studding, and Bracing:

1. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.
2. Maximum Spacing of Studs:
 - a. Boards: Maximum 16 inches o.c.
 - b. Plywood: 12 inches o.c.
3. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
4. Construct beam soffits of material minimum 2 inches thick.
5. Distribute bracing loads over base area on which bracing is erected.
6. When placed on ground, protect against undermining, settlement, and accidental impact.

F. Form Anchors and Hangers:

1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

G. Inserts, Embedded Parts, and Openings:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.

5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.
6. Install formed openings for items to be embedded in or passing through concrete Work.
7. Locate and set in place items required to be cast directly into concrete.
8. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.
9. Frame openings in concrete where indicated on Drawings.
10. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
11. Coordinate Work to avoid cutting and patching of concrete after placement.
12. Temporary Openings:
 - a. Provide temporary ports or openings in formwork as required to facilitate cleaning
 - b. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
 - c. Locate openings at bottom of forms to allow flushing water to drain.
 - d. Remove chips, sawdust, and other debris.
 - e. Thoroughly blow out forms with compressed air just before concrete is placed and inspection.
 - f. Clean forms and surfaces against which concrete is to be placed.
 - g. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

H. Form Ties:

1. Provide sufficient strength and quantity to prevent spreading of forms.
2. Place ties at least 1 inch away from edge of concrete.
3. Leave inner rods in concrete when forms are stripped.
4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.

I. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

J. Construction Joints:

1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
2. Just prior to subsequent concrete placement, remove strip, and tighten forms to conceal shrinkage.
3. Appearance:
 - a. Show no overlapping of construction joints.
 - b. Construct joints to present same appearance as butted plywood joints.
4. Arrange joints in continuous line straight, true, and sharp.

K. Embedded Items:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.

2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

L. Screeds:

1. Set screeds and establish levels for tops of and finish on concrete slabs.
2. Slope slabs to drain where required or as indicated on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete, thoroughly wet forms, and remove freestanding water.

M. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.
2. Staking through membrane is not permitted.

N. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed.
3. Remove chips, sawdust, and other debris.
4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

A. Construct formwork to maintain tolerances according to ACI 301.

B. Camber:

1. According to ACI 301.

C. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus 1 inch from the intended surface indicated.

3.4 FIELD QUALITY CONTROL

A. Inspection:

1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
2. Notify Engineer after placement of reinforcing steel in forms at least six working hours prior to proposed concrete placement.

3. Schedule concrete placement to permit formwork inspection before placing concrete.
4. Failure of forms to comply with specified requirements or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of concrete work. Repair or replace rejected work as directed by Engineer. Make required repair or replacement subject to requirements of these Specifications and approval of Engineer.

END OF SECTION 031000

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SECTION 031500 - CONCRETE JOINTS 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 construction of durable, watertight joints in concrete structures.
- B. Related Requirements:
 - 1. Section 031000 “Concrete Forming and Accessories” for formwork.
 - 2. Section 032000 “Concrete Reinforcing” for reinforcing.
 - 3. Section 033000 “Cast-In-Place Concrete” for cement, and related concrete products.
 - 4. Section 033500 “Concrete Finishing” for concrete finish related work.
 - 5. Section 033600 “Grout” for grout related work.
 - 6. Section 030130.71 “Modifications to Existing Concrete”.
 - 7. Section 055000 “Metal Fabrications” for various metal fabrications.

1.3 ACTION SUBMITTALS

- A. Plastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to CRD standards, details, and samples of factory fabrications.
- B. Thermoplastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to ASTM standards, details, and samples of factory fabrications.
- C. Special Waterstops: Product data including location of use, sample, catalogue cut, technical data, storage requirements, splicing methods, installation instructions, and conformity to CRD, ASTM or FS standards, as applicable.
 - 1. Injectable Waterstop Hose System: In addition to requirements specified above, submit applicator certification by manufacturer of injectable waterstop hose system. Submit manufacturer's specifications for cleaning and preparing surfaces to receive waterstop system and instructions for installation and injection. Include manufacturer product data confirming that materials are recommended for applications indicated and recommendations for inspection.
- D. Premolded Joint Fillers: Product data including location of use, sample, catalogue cut, technical data, storage requirements, and conformity to ASTM standards.

- E. Preformed Expansion Joint Material: Product data including location of use, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to ASTM standards.
- F. Bond Breaker: Product data including location of use, catalogue cut, technical data, storage requirements, and application instructions.
- G. Expansion Joint Dowels: Product data on the complete assembly including dowel material, sizes and dimensions, coatings, expansion dowel caps, installation instructions and conformity to ASTM standards.
- H. Sealant: Product data including location of use, catalogue cut, technical data, storage requirements, mixing and application instructions, and conformity to ASTM standards.
- I. Neoprene Bearing Pads: Product data including location of use, sample, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to AASHTO standards.
- J. Shop Drawings:
 - 1. Submit for injectable waterstop hose system.
 - 2. Include layout, injection and, and details of hose system.

1.4 INFORMATIONAL SUBMITTALS

- A. System and Material Certificates:
 - 1. Certify that materials used within joint system are compatible with each other.
 - 2. Certify that sealant is made for use in continuous immersion in contact with wastewater.

1.5 QUALITY ASSURANCE

- A. Sealant Manufacturer's Field Representative Qualifications:
 - 1. Experience: Performed at least five projects of similar size and complexity within last five years. Be present at work site prior to mixing to instruct on mixing, application, and inspection procedures. Inspect finish of prepared surfaces prior to sealant application.
 - 2. Make at least one additional visit to site as the work progresses and report on each visit to Contractor and the Engineer. Advise whether the application is in accordance with this Section and manufacturer's printed installation instructions.
- B. Applicator Qualifications:
 - 1. Install injectable waterstop hose system by an applicator certified by manufacturer.
 - 2. Provide applicator of reinjectable waterstop hose system having a minimum of 5 years' experience.
- C. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Use materials in a given joint that are compatible with one another. Coordinate selection of suppliers and products to provide compatibility. Do not use asphaltic bond breakers or asphaltic joint fillers in joints receiving sealant.
- B. Product Experience: Provide plastic waterstops, thermoplastic waterstops, injectable waterstop hose system, expansive waterstops, and adhesive waterstops products specifically manufactured for intended purpose and have five years' successfully experience in similar applications.

2.2 MATERIALS - STANDARD WATERSTOPS

- A. Plastic Waterstops: Conform to CRD C572, fabricate by extruding elastomeric plastic compound with virgin polyvinylchloride as basic resins and with compound containing no reprocessed materials. Incorporate an integral fastening system or provide with grommets or prepunched holes between outermost ribs at a spacing of 12 inches on center.
 - 1. Waterstops For Expansion Joints:
 - a. Type: Ribbed type waterstops with a center bulb.
 - b. Minimum Tensile Strength: 1,750 psi per ASTM D638.
 - c. Size: 9 inches by 3/8 inch.
 - d. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Greenstreak Plastic Products: Style 696.
 - 2) Paul Murphy Plastics Co.: Style CR-9380.
 - 3) Vinylex Corp.: Style RLB9-38.
 - 2. Waterstops For Non-Expansion Joints and Joints Indicated:
 - a. Type: Ribbed type waterstops.
 - b. Minimum Tensile Strength: 1,750 psi per ASTM D638.
 - c. Size: 6 inches by 3/8 inch.
 - d. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Greenstreak Plastic Products: Style 679.
 - 2) Paul Murphy Plastics Co.: Style FR-6380.
 - 3) Vinylex Corp.: Style R6-38.
 - 3. Factory Fabrications:
 - a. Provide factory fabrications for waterstop changes of direction, transitions, and intersections:

- 1) Intersections: Vertical ells, flat ells, vertical tees, flat tees, vertical crosses, flat crosses, and special, unusual, or complicated intersections including waterstop intersections of different sizes or configurations, and intersections due to joint offsets.
- b. Make and inspect factory fabrications by waterstop manufacturer.
- c. Provide stub ends of sufficient length to leave only straight butt joints for field splicing.

B. Thermoplastic Waterstops:

1. Waterstops: Fabricate from a fully vulcanized blend of EPDM and polypropylene, Thermoplastic Elastomeric Rubber (TPER), or Thermoplastic Vulcanizite (TPV). Provide material conforming to the following:

Tensile Strength:	2,000 psi per ASTM D638 (TPER) or 2,300 psi per ASTM D412 (TPV)
Elongation:	450 percent per ASTM D638 (TPER) or 530 percent per ASTM D412 (TPV)
100 percent Modulus:	1,000 psi per ASTM D638 (TPER) or 1,000 psi per ASTM D746 (TPV)
Brittle Temperature:	-70 degrees F per ASTM D746
Hardness:	85 Shore A per ASTM D2240
Ozone Resistance:	Passed with no cracking at 450 pphm per ASTM D1171

1. Waterstops For Expansion Joints:

- a. Type: Ribbed type waterstops with a center bulb.
- b. Size: 9 inches by 3/8 inch.
- c. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) JP Specialties: Earth Shield TPV, Style EYJP936 with brass eyelets at 12 inches on center.
 - 2) Westec Barrier Technologies: Envirostop TPER, Style 620 with brass grommets at 12 inches on center.

2. Waterstops For Non-Expansion Joints and Joints Indicated:

- a. Type: Ribbed type waterstops with a center bulb.
- b. Size: 6 inches by 3/8 inch.
- c. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) JP Specialties: Earth Shield TPV, Style EYJP636 with brass eyelets at 12 inches on center.
 - 2) Westec Barrier Technologies: Envirostop TPER, Style 619 with brass grommets at 12 inches on center.

3. Factory Fabrications:

- a. Provide factory fabrications for waterstop changes of direction, transitions, and intersections:
 - 1) Intersections: Vertical ells, flat ells, vertical tees, flat tees, vertical crosses, flat crosses, and special, unusual, or complicated intersections including waterstop intersections of different sizes or configurations, and intersections due to joint offsets.
- b. Make and inspect factory fabrications by waterstop manufacturer.
- c. Provide stub ends of sufficient length to leave only straight butt joints for field splicing.

2.3 MATERIALS - SPECIAL WATERSTOPS

A. Base Seal PVC Waterstops:

1. Conform to CRD C572 and fabricate by extruding elastomeric plastic compound with virgin polyvinylchloride as basic resins with compound containing no reprocessed materials.
2. Minimum Tensile Strength: 1,750 psi per ASTM D638.
3. Basis-of-Design: Provide products as manufactured by Greenstreak Plastic Products, or equal:
 - a. Expansion Joints: Style 925.
 - b. Control Joints: Style 928.
 - c. Construction Joints: Style 927.

B. PVC Retrofit Waterstops for Non-Expansion Joints:

1. Conform to CRD C572 and fabricate by extruding elastomeric plastic compound with virgin polyvinylchloride as basic resins with compound containing no reprocessed materials.
2. Minimum Tensile Strength: 1,750 psi per ASTM D638.
3. Type: T profile.
4. Basis-of-Design: Provide products as manufactured by Greenstreak Plastic Products, or equal.
 - a. Style 609 system complete with Type 304 stainless steel batten bars and 1/4 inch diameter stainless steel expansion bolts.

C. Injectable Waterstop Hose System for Non-Expansion Joints Where Indicated.

1. System: Hose utilizing a spiral core enclosed within an exterior membrane, injectable grout or resin, anchoring clips, packers, and other required accessories.
2. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - a. BBZ USA, Inc.: Duroject Injection Hose with Multigel 850 Injection Resin.
 - b. De Neef Construction Chemicals, Inc.: Injecto Tube with Hydro Active Injecto Grout.

D. Expansive Waterstops for Construction Joints Where Indicated:

1. Type A - Preformed Bentonite and Butyl Rubber Based System:
 - a. Installation Adhesives: Use with expansive waterstops as recommended by waterstop manufacturer.
 - b. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Colloid Environmental Technologies Company: Volclay Waterstop-RX101.
 - 2) Greenstreak Plastic Products: 3/4-inch by 1-inch Swellstop.
 - 3) W.R. Grace: Adcor ES.
2. Type B - Preformed Hydrophilic Rubber Strips:
 - a. Installation Adhesives: Use with expansive waterstops as recommended by waterstop manufacturer.
 - b. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Greenstreak Plastic Products: Hydrotite CJ-1020-2K.
 - 2) Mitsubishi: Adeka Ultraseal MC-2010MN.
 - 3) W.R. Grace: Adcor ES.

E. Preformed Adhesive Waterstops for Construction Joints Where Indicated.

1. System: Rope type preformed plastic waterstop meeting requirements of Federal Specification SS-S-210A.
2. Cross-Sectional Area: Approximately one square inch, unless otherwise indicated.
3. Primer: As recommended by waterstop manufacturer.
4. Basis-of-Design: Provide products as manufactured by Henry Company, or equal:
 - a. Synko-Flex Waterstop SF-302.

2.4 MATERIALS - ACCESSORIES

A. Premolded Joint Filler - Structures: ASTM D1752, Type III, self-expanding cork.

1. Thickness: 1 inch, unless otherwise indicated.

B. Bond Breaker:

1. Bond Breaker Tape: Adhesive-backed glazed butyl or polyethylene tape that adheres to premolded joint filler or concrete surface. Provide tape of same width as the joint.
2. Bond breaker for concrete other than where tape is indicated or specified: Either bond breaker tape or a non-staining type bond prevention coating.
 - a. Acceptable Coating Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Cresset Chemical Company: Crete-Lease Bond Breaker for Tilt-Up.

- 2) Dayton Superior: Sure-Lift J-6 WB.
 - 3) Nox-Crete: Silcoseal Select.
3. Bond Breaker for Expansion Joint Dowels: ASTM C309, Type 2, Class A, water-based white pigmented curing compound.
- C. Preformed Expansion Joint Material: Non-extrudable watertight strip material used to fill expansion joints between structures meeting following criteria:
1. Compressibility: Capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in first 30 minutes after unloading.
 2. Basis-of-Design: Provide products as manufactured by Chase Construction Products, or equal:
 - a. Phyzite 380.
- D. Expansion Joint Dowels: Smooth undeformed steel bars conforming to ASTM A615, Grade 60.
1. Provide dowels straight and clean, free of loose flaky rust, and loose scale.
 2. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inch of dowel diameter and extends no more than 0.04 inch from the end.
 3. Coat bars with a bond breaker on expansion end of dowel. Provide expansion dowel caps on the expansion end.
 - a. Acceptable Manufacturers for Expansion Dowel Caps: Provide products manufactured by one of the following or equal:
 - 1) Dayton Superior Corporation: Style K-11.
 - 2) Heckmann Building Products, Inc.: No. 87.
 - 3) Meadow Steel Products, Inc.: Style 3070 Expansion Tube.
- E. Neoprene Bearing Pads: 50 durometer conforming to AASHTO Standard Specifications for Highway Bridges.
- F. Grout: Non-metallic, non-shrinking as specified in Section 033600 "Grouting."

2.5 MATERIALS - SEALANTS

A. Sealant:

1. Comply with ASTM C920 for following conditions:
 - a. Sealant for Joints in Horizontal Surfaces: Type S or M, Grade P or NS, Class 25.
 - b. Sealant for Joints in Sloping and Vertical Surfaces: Type S or M, Grade NS, Class 25.
 - c. Sealant in Pedestrian and Vehicular Traffic Areas: Use T₁.
 - d. Sealant in Non-Traffic Areas: Type S or M, Grade P, Use NT.

2. Provide sealants made for use in continuous immersion in contact with wastewater. Provide gray colored sealants unless otherwise indicated, specified, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION - WATERSTOPS, GENERAL

- A. Install waterstops for joints indicated and according to manufacturer's published installation instructions and approved submittals.
- B. Include waterstops continuous around corners and intersections to provide a continuous seal.
- C. Provide a minimum number of connections or splices. Replace connections or splices that do not meet specified requirements at no additional cost to Owner.
- D. Secure waterstops in joints before concrete is placed.
- E. Install plastic and thermoplastic waterstops so that half of width is embedded on each side of joint. Install waterstops with a center bulb in expansion joints so center bulb is within the joint width. Provide waterstops completely embedded in void-free concrete.
- F. Terminate waterstops 2 inches below exposed top of walls. Plug center bulbs in expansion joint waterstops with foam rubber, 1 inch, at termination points.
- G. Protect waterstops from damage in intervals between placing waterstops and subsequent placing of concrete. Replace damaged or punctured waterstops at no additional cost to Owner.
- H. Protect plastic waterstops from sunlight when exposed more than 30 days between concrete placements.
- I. Provide waterstops free from form release agent, bond breaker, dirt, concrete splatter, ice, mortar, paint, or other deleterious material that could reduce or destroy bond between waterstop and adjacent concrete.

3.2 INSTALLATION - PLASTIC AND THERMOPLASTIC WATERSTOPS

- A. Field Splices: Make only straight butt joints. Fabricate splices on a bench.
 1. Use a power saw and guide to cut straight ends to be spliced.
 2. Heat fuse weld splices using a Teflon coated thermostatically controlled waterstop splicing iron following manufacturer's recommendations.
 3. Provide finished splices having a cross-section that is dense and free of porosity. Engineer may conduct destructive tests of splices by cutting along one-half of splice length and by cutting perpendicular to splice at several locations on remaining half of splice length.
 4. Completed Splices: Exhibit a continuous and uniform bead of excess melted material with welded material looking similar to parent material.
 5. Show no misalignment of center bulbs or ribs greater than 1/16 inch, lack of fusion, porosity, pinholes, cracks, charred or burnt material, bubbles, or separation of cooled

splice when bent by hand. If a splice displays any of these defects, reject the splice, recut back at least 1 inch from rejected splice on each side, and reweld.

- B. Secure waterstops in wall joints before concrete is placed. If waterstop does not incorporate an integral fastening system, grommets, or prepunched holes, drill holes in waterstops between outermost ribs at each edge. Center waterstop in the joint. Tie both edges of waterstop to reinforcing steel with tie wire as specified for tying reinforcing steel. Secure waterstop centered on and perpendicular to joint and to maintain its position during concrete placement.
- C. Space waterstop ties to match spacing of adjacent reinforcing, but ties need not be spaced closer than 12 inches on center.
- D. Clamp horizontal waterstops in slabs in position with form bulkhead, unless previously set in concrete. Lift waterstop edge while placing concrete below the waterstop. Manually force waterstop against and into placed concrete and cover with fresh concrete, to provide complete encasement of waterstop in concrete.

3.3 INSTALLATION - SPECIAL WATERSTOPS

- A. Install special waterstops at joints only where specifically indicated on Drawings. Provide waterstops continuous around corners and intersections to provide a continuous seal.
- B. Use waterstops of maximum practicable length to provide a minimum number of joints, connections, or splices. Make joints, connections, and splices conforming to manufacturer's recommended.
- C. Terminate waterstops 2 inches below exposed top of walls.
- D. Plug bulbs in PVC retrofit waterstops with foam rubber, 1 inch deep, at termination points.
- E. Base Seal PVC Waterstops: Splice as specified for plastic waterstops. Set base seals for expansion joints on concrete sleepers, not less than 24 inches wide, and sleeper covered with two layers of sheet material such as vapor barrier material.
 - 1. Do not fasten base seal by nails, but firmly hold in position by bulkhead form. Base seals at non-expansion joints may be set on vapor barrier material that extends at least two feet on each side of the joint.
- F. PVC Retrofit Waterstops: Splice and secure projecting portion to reinforcing steel as specified for plastic waterstops. Clean existing concrete of foreign material and patch to form a smooth plane surface. Use adhesives, fastening devices, and fastener spacing conforming to manufacturer's recommendations.
- G. Injectable Waterstops:
 - 1. Use maximum hose length of 25 linear feet. Splice consecutive lengths of hose by overlapping in accordance with manufacturer's specifications.
 - 2. Hold hose in place with anchor clips at manufacturer's recommended spacing.
 - 3. Do not fasten injection hoses to reinforcing steel.

4. Patch visible honeycombs at concrete surface prior to injection. Perform injection in compliance with manufacturer's specifications and ensure injection hose is properly sealed upon completion.

H. Expansive Type and Preformed Adhesive Waterstops:

1. Clean and prepare joint surfaces, install primers or adhesives, and install Type A expansive, Type B expansive, or preformed adhesive waterstops on dry surfaces in accordance with manufacturer's instructions, including concrete cure, temperature conditions, and splices.
2. Use mechanical fasteners to secure Type A expansive or Type B expansive waterstops to previously placed vertical and overhead concrete surfaces and other locations, as recommended by manufacturer. Protect installed waterstops from moisture and keep dry until subsequent placement of concrete.

3.4 INSTALLATION - CONSTRUCTION JOINTS

- A. Make construction joints only at locations indicated or as approved by Engineer. Submit additional or relocation of construction joints proposed by Contractor to Engineer for written approval. Do not eliminate construction joints.
- B. Locate additional or relocated joints where they least impair member strength. In general, locate joints within middle third of spans of slabs, beams, and girders.
 1. If a beam intersects a girder at joint, offset joint a distance equal to twice the width of member being connected.
 2. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
 3. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.
- C. Unless otherwise indicated, provide joints perpendicular to main reinforcement. Continue reinforcing steel through joint as indicated. Provide inclined dowels at construction joints in beams, as detailed.
- D. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations indicated.
- E. Roughened Construction Joints:
 1. At construction joints and at concrete joints indicated, uniformly roughen concrete surface with chipping tools to expose a fresh face 1/4 inch of a full amplitude, distance between high and low points and side to side.
 2. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding.
 3. At least two hours before and again shortly before new concrete is deposited, saturate joints with water.

4. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Apply a coating to surfaces at least 1/8 inch, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before neat cement dries.

3.5 INSTALLATION - EXPANSION JOINTS

- A. Make expansion joints at locations indicated. Do not eliminate or relocate expansion joints.
- B. Provide expansion joints 1 inch in thickness, unless otherwise indicated.
- C. Provide center bulb type waterstops, sealant grooves, and sealants in wall and slab expansion joints in liquid retaining structures and at other locations indicated.
- D. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on each side of joint.
- E. Where indicated, install smooth dowels at right angles to expansion joints. Align dowels parallel with finished surface. Rigidly hold in place and support during concrete placement.
 1. Unless otherwise indicated, apply a bond breaker to one end of dowels through expansion joints.
 2. Mask waterstops to prevent bond breaker from running or dripping onto them. Remove masking prior to concrete placement.
 3. Provide expansion dowel caps on ends of expansion joint dowels to which bond breaker has been applied.
- F. Place joint filler over joint face allowing for sealant grooves as indicated. Butt joint filler tight against waterstop, if present. Tape joint filler splices to prevent intrusion of mortar. Position premolded joint filler material parallel to finished surfaces. Secure joint filler against displacement during concrete placement and consolidation. Seal expansion joints as indicated.

3.6 INSTALLATION - PARTIAL CONTRACTION JOINTS

- A. Make partial contraction joints at locations indicated. Do not eliminate or relocate partial contraction joints.
- B. Provide waterstops, sealant grooves, and sealants in wall and slab partial contraction joints in liquid retaining structures and at other locations indicated.
- C. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on Drawings. Coat concrete surface with a bond breaker prior to placing new concrete against it as indicated on Drawings.
 1. Do not coat reinforcement or waterstops with bond breaker. Mask waterstops and reinforcing passing through joint to prevent bond breaker from running or dripping on to them. Remove masking prior to concrete placement.

3.7 INSTALLATION - SEALANTS

- A. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust, and other deleterious materials that will impair bond.
- B. Apply sealant conforming to manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing.
- C. Apply masking tape to each side of joint prior to sealant installation. Remove masking tape afterwards, along with any spillage to leave a sealant installation with neat straight edges.

3.8 INSTALLATION - PREFORMED EXPANSION JOINT MATERIAL

- A. Install preformed expansion joint material in conformance with manufacturer's recommendations; including surface preparation, adhesive installation, heat welding, and set time.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect system components verifying that installation conforms to manufacturer's installation instructions.,
 - 1. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

- A. Clean adjacent surfaces removing excess spills.
- B. Protect installed products until subsequent work is installed. For exposed materials, protect from damage until Substantial Completion.

END OF SECTION 031500

SECTION 032000 - 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. Reinforcing bars.
- 2. Welded wire fabric.
- 3. Reinforcement accessories.

- B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for form materials, and accessories required to form cast-in-place concrete.
- 2. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete.
- 3. Section 033500 "Concrete Finishing" for reinforcement for concrete floor toppings.

1.3 COORDINATION

- A. Coordinate Work of this Section with placement of formwork, formed openings, masonry dowels, and other Work.

1.4 ACTION SUBMITTALS

- A. Shop Drawings:

- 1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel and welded wire fabric.
- 2. Indicate bending and cutting schedules.
- 3. Indicate supporting and spacing devices.
- 4. Placement Drawings:
 - a. Walls: Show elevations from outside, looking towards the structure, at a minimum scale of 1/4 inch to one foot.
 - b. Slabs: Show top and bottom reinforcement on separate plan views, as needed for clarity.
 - c. Beams and Columns: Show schedules with sections, elevations, and stirrup/tie spacing.

- d. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements, and assemblies, all as required for the fabrication and placement of concrete reinforcement.
 - e. Reference bars to same identification marks shown on bar bending details. Identify bars to have special coatings or to be of special steel or special yield strength.
- B. Samples: Two samples of each type of mechanical reinforcing steel coupling system.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Submit certified copies of mill test report of reinforcement materials analysis.
- C. Certified copy of test reports for each foreign manufactured steel proposed for use. Provide tests specifically made for this project by a domestic independent testing laboratory certified to perform the tests. Test for conformity to applicable ASTM Standard.
- D. Copy of CRSI certification for plant producing epoxy-coated reinforcement.
- E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 QUALITY ASSURANCE

- A. Perform Work according to CRSI 10-MSP, ACI 301, and ACI 318.
- B. Prepare Shop Drawings according to ACI SP-66.
- C. Maintain one copy of each standard affecting Work of this Section on Site.
- D. Epoxy-coated Reinforcement. Produced by a plant certified by the CRSI Epoxy Plant Certification Program.
- E. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Ship and store reinforcement with bars of same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing same "mark" designations as those shown on submitted placement drawings. Indicate that reinforcing is weldable on tags

for ASTM A706 reinforcing and for ASTM A615 reinforcing meeting specified requirements in PART 2.

- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture by storing off ground, in clean, and dry location.
 - 2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel:
 - 1. Comply with ASTM A615.
 - 2. Yield Strength: 60 ksi.
 - 3. Billet Bars: Deformed.
 - 4. Finish: Uncoated.
- B. Deformed Reinforcement required on Drawings to be Field Bent or Welded:
 - 1. Material: Steel bars.
 - 2. Comply with ASTM A706.
 - 3. Yield Strength: 60 ksi.
 - 4. Finish: Uncoated.
 - 5. ASTM A615, Grade 60 may be substituted for ASTM A706 subject to the following:
 - a. Actual yield strength of reinforcing steel based on mill tests does not exceed specified yield strength by more than 18,000 psi. Retests not to exceed this value by more than an additional 3,000 psi.
 - b. Ratio of actual ultimate tensile strength to actual tensile yield strength of reinforcement is not less than 1.25.
 - c. Carbon equivalency (CE) is 0.55 percent or less.
- C. Spiral Reinforcement:
 - 1. ASTM A615, Grade 60 for plain or deformed bars.
 - 2. ASTM A1064 for cold-drawn wire.

- D. Deformed Wire:
 - 1. Comply with ASTM A1064.
 - 2. Finish: Uncoated.
- E. Plain Wire:
 - 1. Comply with ASTM A1064.
 - 2. Finish: Uncoated.
- F. Fabricated Welded Deformed Wire Fabric:
 - 1. Comply with ASTM A1064 and ASTM A615 Grade 60 deformed bars.
 - 2. Configuration: Flat sheets.
 - 3. Finish: Uncoated.
- G. Welded Plain Wire Fabric:
 - 1. Comply with ASTM A1064.
 - 2. Configuration: Flat sheets.
 - 3. Finish: Uncoated.

2.2 FABRICATION

- A. Fabricate concrete reinforcement according to CRSI 10-MSP and ACI 318.
- B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups, and tie hooks as indicated.
- C. Form reinforcement bends with minimum diameters according to ACI 318.
- D. Bend bars cold. Do not straighten or rebend bars.
- E. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318.
- F. Saw cut bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded. Terminate saw cut ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.
- G. Fabricate column reinforcement with offset bends at reinforcement splices.
- H. Form spiral column reinforcement from minimum 3/8-inch-diameter continuous deformed bar or wire.
 - 1. Provide a minimum of 1-1/2 finishing turns at the top and bottom.
 - 2. Splices. Provide tension lap splices at least 48 bar diameters, but not less than 12 inches in length. Do not use welded splices unless specifically approved by Engineer.
 - 3. Provide spacers as recommended by the CRSI.
- I. Form ties and stirrups as indicated

- J. Weld reinforcement, only where indicated or specifically approved by Engineer. Weld reinforcement conforming to AWS D1.4.

2.3 ACCESSORY MATERIALS

A. Tie Wire:

1. Minimum 16 gage, annealed type. Use black wire to tie uncoated reinforcing.

B. Reinforcing Steel Accessories:

1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.

C. Reinforcing Splicing Devices:

1. Type: Exothermic welding type; full tension and compression. Use only where indicated.

D. Type: Mechanical threaded; full tension and compression.

1. Use only where indicated. Meet all ACI 318 requirements. Provide threaded type with cap on female end to exclude dirt, debris, and wet concrete. Torque couplers to manufacturer's recommended value.
2. Unless otherwise indicated, mechanical reinforcing splicing devices shall produce a splice strength in tension or compression of not less than 125 percent of ASTM specified minimum yield strength of reinforcing bar. Base yield strength on Grade 60 reinforcing unless otherwise indicated or specified.
3. Compression type mechanical splices shall provide concentric bearing from one bar to other bar.
4. Size: To fit joined reinforcing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with CRSI 10-MSP for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.
- B. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.
- C. Do not weld reinforcing steel bars either during fabrication or erection unless indicated or as specified herein, or unless prior written approval has been obtained from Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

- D. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits, or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the prior approval of Engineer.
- E. Place, support, and secure reinforcement against displacement. Secure dowels in place before placing concrete.
- F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- G. Do not deviate from required position beyond specified tolerance.
- H. Do not field bend reinforcing unless indicated or specifically authorized in writing by Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using exothermic welding type reinforcing splicing devices, or otherwise repair damaged reinforcing bars as directed by Engineer without additional compensation. Do not bend reinforcement after it is embedded in concrete unless indicated.
- I. Do not displace or damage vapor retarder.
- J. Chairs, Bolsters, Bar Supports, and Spacers:
 - 1. Size and Shape: To support reinforcement and prevent displacement of reinforcing during concrete placement conditions.
 - 2. Furnish load-bearing pad on bottom to prevent vapor retarder puncture.
 - 3. Use precast concrete blocks where reinforcing steel is to be supported over soil.
 - 4. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by Engineer.
- K. Spacing:
 - 1. Space reinforcement bars with minimum clear spacing according to ACI 318.
 - 2. If bars are indicated in multiple layers, place upper bars directly above lower bars.
- L. Determine clear concrete cover based on exposure to the environment. Provide the following clear concrete cover over reinforcement, unless indicated otherwise:
 - 1. Concrete cast against and permanently exposed to earth: 3 inches.
 - 2. Concrete exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls: 2 inches.
 - b. Beams and columns (ties, spirals, and stirrups): 2 inches.
 - 3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells, and folded plate members: 1 inch.

- b. Beams and columns (ties, spirals, and stirrups): 1-1/2 inches.

M. Splicing:

1. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the reinforcement subject to direct tension shall be butted and joined with complete penetration welds to develop, in tension, at least 125 percent of the specified yield strength of the bar. Offset splices in adjacent bars the distance of a Class B splice or 30 inches, whichever is greater.
2. Welded Wire Fabric: Provide lap splices in accordance with the requirements of ACI 318 but not less than 12 inches. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
3. Reinforcing Splicing Devices: Use only where indicated. Offset splices in adjacent bars by at least 30 bar diameters. Use only for special splice and dowel conditions indicated or approved by Engineer.
4. After installation of mechanical reinforcing steel coupling system, on reinforcement, repair coating damage in accordance with applicable ASTM standard. Coat all parts of mechanical connectors used on coated bars including steel splice sleeves, bolts, and nuts with same material used for repair of damaged coating.
5. Locate reinforcement splices at point of minimum stress, unless indicated otherwise.
6. Obtain approval of splice locations from Engineer.

- N. Place dowels for concrete masonry units in accordance with approved placement drawings.

3.2 TOLERANCES

- A. Install reinforcement within following tolerances for slabs, beams, girders, columns, walls, and foundation elements:
1. Member Depth (or Thickness) Greater Than 12 Inches:
 - a. Reinforcement Location: Plus or Minus 1/2 inch.
 2. Member Depth (or Thickness) Less Than or Equal to 12 Inches:
 - a. Reinforcement Location: Plus or Minus 3/8 inch.

3.3 FIELD QUALITY CONTROL

- A. Inspection by Engineer: When reinforcing is complete and ready for inspection, notify Engineer at least six working hours prior to proposed concrete placement.
- B. Do not cover reinforcing steel with concrete until reinforcement, including the size, spacing and position has been inspected by Engineer and Engineer's release to proceed with concreting has been obtained. Keep forms open until Engineer has completed inspection of the reinforcement.

END OF SECTION 032000

SECTION 033000 - 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: Cast-in-Place Concrete for various items indicated in Contract Documents.
 - 1. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of Contractor. Provide field sampling, testing, inspection, and related laboratory tests.
- B. Related Requirements:
 - 1. Section 031000 “Concrete Forming and Accessories” for formwork and accessories.
 - 2. Section 032000 “Concrete Reinforcing” for requirements for reinforcing steel and supports.
 - 3. Section 032500 “Concrete Joint and Joint Accessories”.
 - 4. Section 033500 “Concrete Finishing” for finishing of concrete floor and wall surfaces.
 - 5. Section 033900 “Concrete Curing” for curing of concrete surfaces.
 - 6. Various Sections in Divisions 22 and 23: Mechanical items for casting into concrete.
 - 7. Various Sections in Divisions 26 and 27: Electrical items for casting into concrete.

1.3 COORDINATION

- A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

1.4 ACTION SUBMITTALS

- A. Submit product data for:
 - 1. Sources of cement, fly ash or ground granulated blast furnace slag, aggregates, and batched concrete. Indicate name and address of mill, quarry, or plant.
 - 2. Air entrainment admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

4. Cold weather and hot weather concreting plans demonstrating how concrete will meet the requirements of this Section including but not limited to concrete mixes, placement, curing and protection.
- B. Concrete Mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type, and manufacturer of cement and type and manufacturer of fly ash or ground granulated blast furnace slag. Provide either subparagraph 1. or 2., below, for each mix proposed.
1. Standard deviation data for each proposed concrete mix based on statistical records. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
 - a. Date of sampling and name of testing laboratory.
 - b. Name of concrete batch plant.
 - c. Water cementitious ratio.
 - d. Slump of batch.
 - e. Air content of batch.
 - f. Compressive strengths of all cylinders tested at that age in that batch.
 - g. If available, temperature and unit weight of batch.
 - h. Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.
 2. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.
- C. Concrete Mixes: Shrinkage.
- D. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.
- E. Samples: Fine and coarse aggregates, if requested for examination by Engineer.

1.5 INFORMATIONAL SUBMITTALS

- A. Test Reports:
1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
 2. Cement and fly ash or ground granulated blast furnace slag: Conformance to ASTM standards, including chemical analysis and physical tests.
- B. Certifications:
1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify that Contractor is not associated with independent testing laboratory proposed for use by Contractor nor does Contractor or its officers have a beneficial interest in the laboratory.
3. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.

C. Qualifications:

1. Independent Testing Laboratory:
 - a. Name and address.
 - b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
 - c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
 - d. Names and qualifications of the supervising laboratory technicians.
 - e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by Engineer.
 - f. Submit as required above for other organizations that will provide external technical services.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.7 QUALITY ASSURANCE

- A. Comply with ACI 318 and ACI 350 and other stated specifications, codes, and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.
- B. Independent Testing Laboratory: Meet requirements of ASTM E329 and ASTM C1077. Do not use laboratories affiliated and having a beneficial interest with Contractor or its officers.
- C. Provide concrete uniform in color and appearance.
- D. Preconstruction Meeting: At least 10 working days before first concrete placement, hold a meeting to review concrete placement requirements, waterstop placement, jointing, concrete curing, hot and cold weather concreting, and finishing. Review, with the attendance of the plasticizer manufacturer, the properties and techniques of batching and placing concrete containing high-range water-reducing admixture. Notify all parties involved, including Engineer, of the meeting at least 10 working days prior to its scheduled date. Prepare an agenda for the meeting. Take meeting minutes and distribute to meeting attendees.
- E. If during work progress, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, Engineer may order such changes in proportions or

materials, or both, as may be necessary to secure the specified properties. Make ordered changes without additional compensation.

- F. If during work progress, materials from the sources originally accepted change in characteristics, make new acceptance tests of materials and establish new concrete mixes with assistance of an independent testing laboratory, without additional compensation.
- G. Provide field testing and inspection services and related laboratory tests. Perform testing methods conforming to latest applicable ASTM methods. Test following items to verify conformity with this Section:
 - 1. Concrete Placements: Compressive strength (cylinders), temperature, slump, and air content.
 - 2. Other materials that may require field testing.
- H. Concrete Placement: Compressive strength (cylinders), temperature, slump, and air content.
- I. Provide laboratory tests of samples, constituents, and as-placed concrete. Materials incorporated in the work shall conform to accepted samples.
- J. Perform Work according to ACI 301 and 350.
- K. Comply with ACI 305R when placing concrete during hot weather.
- L. Comply with ACI 306.1 when placing concrete during cold weather.
- M. Acquire cement and aggregate from one source for Work.

1.8 AMBIENT CONDITIONS

- A. Maintain concrete temperature after installation at minimum 50 degrees F for minimum seven days.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96, desiccant or water method.

2.2 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: Domestic portland cement conforming to ASTM C150. Cement shall be low alkali cement. Do not use air entraining cements. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns. Cement brand must be approved by Engineer and one brand shall be used throughout the work.

1. Comply with ASTM C150, Type II - Moderate Sulfate Resistant.
2. Type: Portland.

C. Aggregates:

1. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33. Grading requirements are listed in ASTM C33, Table 3 for the specified coarse aggregate size number listed in Table 1. Limits of deleterious substances and physical property requirements are listed in ASTM C33, Table 4 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.
3. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using project proposed cement. If aggregates proposed do not meet this requirement, then satisfy either subparagraph a. or b. below.
 - a. Total equivalent alkali content of the cement: Do not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C150.
 - b. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement and fly ash or ground granulated blast furnace slag proposed for the project. Proportions of cement-fly ash mix or cement-ground granulated blast furnace slag mix shall be the same as those proposed for the project.

D. Water:

1. Comply with ACI 318 and ACI 350 (350M).
2. Potable, without deleterious amounts of chloride ions.

E. Admixtures: Use admixtures free of chlorides and alkalis, except for those attributable to drinking water. Provide admixtures from same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with concrete mix including other admixtures and made for use in concrete in contact with potable water after 30 days of concrete curing. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from Engineer. Use retarding or accelerating water reducing admixtures when so approved.

1. Air Entrainment: Comply with ASTM C260.
2. Chemical:
 - a. Comply with ASTM C494.
 - b. Type A - Water Reducing.
 - c. Type F - Water Reducing, High Range.
 - d. Type G - Water Reducing, High Range, and Retarding.
3. Plasticizing:
 - a. Comply with ASTM C1017/(C1017M).
 - b. Type I, plasticizing or II, plasticizing and retarding.

F. Supplementary Cementitious Materials:

1. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss on Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
2. Ground Granulated Blast Furnace Slag: Grade 100 or Grade 120 ground granulated blast furnace slag complying with ASTM C989. Provide ground granulated blast furnace slag from a single source and uniform in color. Mill test reports submitted must be within 6 months of submittal date.
3. Silica Fume: Comply with ASTM C1240.

2.3 CONCRETE MIX

- A. Engage an independent testing laboratory to establish concrete mixes and perform sampling and laboratory testing of products and materials.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
 1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 318 and ACI 350 and based on the modification factors for standard deviation tests contained in ACI 318 and ACI 350.
 2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28-day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. Cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. Resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.
- D. Test fly ash or ground granulated blast furnace slag and concrete mixture to provide test data confirming that materials in combination with the cement meet strength requirements and are compatible with other concrete additives.
- E. Test aggregates for potential alkali reactivity in accordance with ASTM C1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3 month intervals.

- F. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with compression strength requirements in conformity with the provisions of ACI 318.
- G. Entrained Air: Measure by ASTM C231 as shown in Table 1.
 - 1. If proposed air entrainment admixture requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in admixture submittal.
- H. Concrete Slump: Measure by ASTM C143 as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 inches to 10 inches.
- I. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1

Class	Design Strength 1	Cement 2	Fine Aggregate 3	Coarse Aggregate 3	Cementitious Content 4
A	2500	Type II	Sand	57 (9)	440
E1	4500	Type II	Sand	467	560
E2	4500	Type II	Sand	57	580
E3	4500	Type II	Sand	67	610

Class	W/C Ratio 5	SCM 6	AE Range 7	WR 8	HRWR 10	Slump Range Inches
A	0.62 max.	Yes	3.5 to 5	Yes	No	1-4
E1	0.42 max.	Yes	3.5 to 5	No	Yes	7-10
E2	0.42 max.	Yes	3.5 to 5	No	Yes	7-10
E3	0.42 max.	Yes	3.5 to 5	No	Yes	7-10

TABLE NOTES:

1. Minimum compressive strength in psi at 28 days.
2. ASTM designation in ASTM C150.
3. Size Number in ASTM C33.
4. Minimum cementitious content in pounds per cubic yard where fly ash or ground granulated blast furnace slag is used cementitious content is defined as cement content plus fly ash or ground granulated blast furnace slag content.
5. W/C is Maximum Water Cementitious ratio by weight.

6. Supplementary Cementitious Material (SCM) fly ash content in the range of 23 - 25 percent of the total cement content plus fly ash content, by weight. If ground granulated blast furnace slag is used in lieu of fly ash, the content of ground granulated blast furnace slag shall be in the range of 25 - 45 percent of the total cement plus ground granulated blast furnace slag content, by weight.
 7. AE is percent air entrainment.
 8. WR is water reducing admixture.
 9. Except as specified in Section 260543 for concrete electrical raceway encasement.
 10. HRWR is high-range water-reducing admixture.
- J. Shrinkage Tests: Perform shrinkage tests on the design mix for all Class D and Class E concrete. The tests shall conform to ASTM C157 as modified by ASTM C596 for curing, storage, and comparator readings. Use concrete specimens. Do not use mortar specimens.
1. Average Shrinkage: At 25 days of air storage do not exceed 0.036 percent.
 2. Make tests with at least three different brands of cement. Only brands demonstrating a shrinkage value within 10 percent of the brand with the lowest shrinkage value at 25 days of air storage will be acceptable.
- K. Admixtures:
1. Include admixture types approved by Engineer and their quantities in concrete mix designs.
 2. Cold Weather:
 - a. ASTM C494 Type E admixture may be used in cold weather, if approved by Engineer.
 - b. Use of admixtures will not relax cold-weather placement requirements.
 3. Hot Weather:
 - a. ASTM C494 Type D admixture may be used in hot weather, if approved by Engineer.
 - b. Use of admixtures will not relax hot-weather placement requirements.
 4. Add air entrainment admixture to all concrete.
 5. Add water reducing admixture to all concrete.
- L. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C94.

PART 3 - EXECUTION

3.1 MEASURING MATERIALS

- A. Provide concrete composed of portland cement, fly ash or ground granulated blast furnace slag, fine aggregate, coarse aggregate, water, and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C94. Batch all constituents, including admixtures, at the plant. High-range water reducing admixtures may be added in the field.

- B. Measure materials for batching concrete by weighing in conformity with and within tolerances given in ASTM C94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.
- C. Weigh cement and fly ash or ground granulated blast furnace slag in individual weigh batchers that are separate and distinct from weigh batchers used for other materials. When cement and fly ash or ground granulated blast furnace slag are weighed in a cumulative weigh batcher, the cement shall be weighed first.
- D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record number of gallons of water as-batched on printed batch tickets.
- E. Dispense admixtures either manually using calibrated containers or measuring tanks or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air entrainment and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTING

- A. Provide ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C94 and produced by a plant certified by the NRMCA. Do not hand-mix. Use truck mixers carrying a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- C. Keep water tank valve on each transit truck locked at all times. Any addition of water must be directed by Engineer. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.
- D. Comply with ACI 318 and ASTM C94 for central plant and rolling stock equipment and methods.
- E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Do not retemper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.

- G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.2 I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.
- H. Furnish a delivery ticket for ready mixed concrete to Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash or ground granulated blast furnace slag, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- I. Temperature and Mixing Time Control:
 - 1. In cold weather (see Paragraph 3.8, C) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
 - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
 - 3. In hot weather (see Paragraph 3.8, D), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
 - 4. Maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in the following Table 2:

TABLE 2

AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER)	MAXIMUM TIME
--	-----------------

(27 Degrees C) 80 Degrees F to 90 Degrees F (32 Degrees C)	45 minutes
(21 Degrees C) 70 Degrees F to 79 Degrees F (26 Degrees C)	60 minutes
(5 Degrees C) 40 Degrees F to 69 Degrees F (20 Degrees C)	90 minutes

- 5. If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed 90 minutes.

3.3 EXAMINATION

- A. Verify requirements for concrete cover over reinforcement.
- B. Verify that anchors, seats, plates, reinforcement, piping, electrical conduits, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

- C. At all times batch, mix, transport, place, and cure concrete to the inspection of Engineer. Advise Engineer of readiness to proceed at least 24 hours prior to each concrete placement. Engineer will inspect the preparations for concreting, including preparation of previously placed concrete, reinforcing and alignment, cleanliness, and tightness of formwork. Do not place concrete without the inspection and acceptance of Engineer.

3.4 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts, and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless indicated on Drawings.
- E. Do not embed electrical conduits in concrete unless indicated on Drawings.
- F. Fabricate piping and conduit such that cutting, bending, or relocation of reinforcing steel is not required. Satisfy the following for pipes and conduits embedded within a slab or wall (other than those merely passing through), unless otherwise indicated on Drawings or approved:
 - 1. Maximum outside dimension of pipe or conduit: Be not greater than one third the overall thickness of slab or wall.
 - 2. Spacing of pipes or conduits: Be greater than or equal to three diameters or widths on center.
- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.
- I. Position embedded anchor bolts using templates.
- J. Correct embedded items not installed in the location or alignment needed or displaced by concrete placement without additional compensation.

3.5 PREPARATION

- A. Previously Placed Concrete:
 - 1. Prepare joints as specified in Section 031500 "Concrete Joints and Accessories".

- B. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- C. Remove water from areas receiving concrete before concrete is placed.

3.6 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to Owner, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finish ability are observed:
 - 1. Gradation of aggregate.
 - 2. Proportion of fine and coarse aggregate.
 - 3. Percentage of entrained air, within the allowable limits.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability, and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 033500 "Concrete Finishing".

3.7 INSTALLATION

- A. Placing Concrete:
 - 1. Place concrete according to ACI 301, 318, and 350.
 - 2. Notify testing laboratory and Engineer minimum 24 hours prior to commencement of operations.
 - 3. Ensure that reinforcement, inserts, embedded parts, formed expansion and contraction joints, are not disturbed during concrete placement.
 - 4. Install vapor retarder under interior slabs on grade according to ASTM E1643.
 - 5. Lap vapor retarder joints minimum 6 inches and seal watertight by adhesive applied between overlapping edges and ends.
 - 6. Repairs:
 - a. Repair vapor retarder damaged during placement of concrete reinforcement.
 - b. Using vapor retarder material, lap over damaged areas minimum 6 inches and seal watertight.
 - 7. Verify that formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
 - 8. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete

previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.

9. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, determine slump at point of truck discharge and determine air content at point of placement.
10. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
11. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
12. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.
13. Slabs:
 - a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in placement. If there is a delay in placement, spade and consolidate concrete placed after the delay at the edge of previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
 - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep top surface of the wall moist to prevent cold joints.
14. Formed Concrete:
 - a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes near the surface of concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12 inch to 24 inch lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15 feet; maximum lift thickness not to exceed 7 feet.
15. Bollards: Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.
16. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
17. Place floor slabs in indicated checkerboard pattern.

B. Compacting:

1. Consolidate concrete by vibration and puddling, spading, rodding, or forking so that concrete is completely worked around reinforcement, embedded items, and openings and into corners of forms. Continuously perform puddling, spading, rodding, and forking

- along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. Compact concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
 3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18 inches to 30 inches apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
 4. Concrete Slabs: Vibrate concrete slabs less than 8 inch thick by vibrating screeds. Vibrate concrete slabs 8 inches and thicker by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
 5. Walls and Columns: Use internal vibrators rather than form vibrators, unless otherwise approved by Engineer. General: for each vibrator needed to level the batch at the point of discharge, use one or more additional vibrators to densify, homogenize, and perfect the surface. Insert vibrators vertically at regular intervals, through fresh concrete and slightly into the previous lift, if any.
 6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
 - a. Frequency of vibrator returns to normal.
 - b. Surface appears liquefied, flattened and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into surface, but has not disappeared.

3.8 PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Protect finished surfaces and slabs whenever ambient conditions of humidity, temperature, sunlight, and wind may result in the rapid evaporation of water from the concrete, to prevent checking and crazing, until the beginning of curing.
- C. Cold Weather Concreting:
 1. For this Specification, 'cold weather' is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of highest and lowest temperature during the period from midnight to midnight.
 2. Batch, deliver, place, cure, and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
 3. Review cold weather concreting plan at preconstruction meeting. Include methods and procedures for use during cold weather including the production, transportation, placement, protection, curing, and temperature monitoring of concrete and procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
 4. Maintain minimum temperature of concrete immediately after placement and during the protection period as indicated in Table 3. The temperature of the concrete in place and

during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Minimum Concrete
Temperatures For
Section Dimensions

Minimum Concrete Temperature:	<u>< 12 inches</u> 55 degrees F	<u>12 - 36 inches</u> 50 degrees F
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5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.
 - a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete, where 7 days at an average 50 degrees F equals 350 degree-days.
 - b. To calculate the weighted average daily air temperature, sum hourly measurements of air temperature in the shade at concrete surface taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
6. Do not use salt, manure, or other chemicals for protection.
7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air-dry concrete for at least 3 days prior to first exposure to freezing temperatures.
8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

D. Hot Weather Concreting:

1. For this Specification, 'hot weather' is defined as any combination of high air temperatures, low relative humidity, and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour.
2. Batch, deliver, place, cure, and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
 - b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.2 I.4. Provide vibration immediately after placement.
 - c. Engineer may direct Contractor to immediately cover concrete with sheet curing material.
3. Review hot weather concreting plan at preconstruction meeting. Include methods and procedures for use during hot weather, including production, placement, and curing.

3.9 REMOVAL OF FORMS

- A. Do not remove forms before concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing, whichever is longer.

TABLE 4

Forms for	Degree Days
Beams and slabs	500
Walls and vertical surfaces	100

(See definition of degree-days in Paragraph 3.8C).

- B. Do not remove shores until concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.
- C. In cold weather when temperature of concrete exceeds ambient air temperature by 20 degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.10 FIELD QUALITY CONTROL

- A. Inspection and Testing: Performed by Owner's testing laboratory according to ACI 318.
- B. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review and approval prior to commencement of Work.
- D. Concrete Inspections:
1. Continuous Placement Inspection: Inspect for proper installation procedures.
 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- E. Strength Test Samples:
1. Sampling Procedures: Comply with ASTM C172.
 2. Cylinder Molding and Curing Procedures:
 - a. Comply with ASTM C31.
 - b. Cylinder Specimens: Standard cured.
 3. Sample concrete and make one set of five cylinders for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area for slabs and walls. Form specimens in 6 inch diameter by 12 inch long non-absorbent cylindrical molds.

4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch, if less than five batches are used.
5. Make one additional cylinder during cold weather concreting and field cure.

F. Field Testing:

1. Slump Test Method: Comply with ASTM C143.
2. Air Content Test Method: Comply with ASTM C173.
3. Temperature Test Method: Comply with ASTM C1064.
4. Compressive Strength Concrete:
 - a. Measure slump and temperature for each sample. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
 - b. Measure air content in air-entrained concrete for each sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, use the latter test method. When concrete is pumped, air content will be determined at point of placement.

- G. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations.

H. Cylinder Compressive Strength Testing:

1. Test Method: Comply with ASTM C39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at seven days.
4. Test one cylinder at fourteen days.
5. Test two cylinders at 28 days.
6. Retain one cylinder for 56 days for testing when requested by Engineer.
7. Dispose of remaining cylinders if testing is not required.
8. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths without additional compensation.

I. Core Compressive Strength Testing:

1. Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. Use results of tests on such cores as basis for acceptance, rejection, or determining the continuation of concrete work. Right of Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve Contractor from meeting specification requirements. Cooperate in

obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair core holes with non-shrink grout as specified in Section 036000 "Grouting". Work of cutting, testing, and repairing the cores will be at the expense of Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of Owner.

2. Sampling and Testing Procedures: Comply with ASTM C42.
3. Test Acceptance: According to ACI 318.
4. Drill three cores for each failed strength test from failed concrete.

J. Patching:

1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. It is the intent of these Specifications to require quality work including forming, mixing, and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
3. As soon as forms have been stripped and concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.
4. Immediately after removal of forms, remove tie cones and metal portions of ties as specified in Section 031000 "Concrete Forming and Accessories". Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16 inchbrush coat of neat cement slurry mixed to consistency of a heavy paste. Immediately plug hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
5. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days as necessary to bring surface down with parent concrete. Do not damage or stain virgin skin of surrounding parent concrete. Wash thoroughly to remove rubbed matter.
6. For very heavy (generally formed) patches, Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

7. Patch imperfections according to ACI 301.
8. Defective concrete and honeycombed areas: Chip down square and at least 1 inch 1-inch deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8 inch wide around the steel. For areas less than 1-1/2 inches deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2 inch layers on successive days, each layer being applied with slurry as described above.

K. Defective Concrete:

1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.11 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.8E. Furthermore, Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation. In such cases of failure to meet strength requirements, Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is Contractor.
- B. When the tests on control specimens of concrete fall below the required strength, Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Table 1, Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Perform coring and testing, load tests, and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation.

- C. Should the strength of test cylinders fall below 60 percent of required minimum 28 day strength, concrete shall be rejected, removed, and replaced without additional compensation.

3.12 SCHEDULE

- A. Following Table 5 are general applications for various concrete classes and design strengths:

TABLE 5

<u>Class</u>	<u>Design Strength</u> (psi)	<u>Description</u>
A	2,500	Concrete fill, concrete fill for bollards, electrical raceway encasement and pipe encasement.
E1	4,500	Structural concrete foundation mats and slabs, walls, and footings 24 inches and greater in thickness.
E2	4,500	Except as noted above for Class E1 concrete: Structural concrete greater than 10 inches in thickness including walls, slabs on grade, elevated slab and beam systems, columns, grade beams, and all other structural concrete greater than 10 inches in thickness.
E3	4,500	Structural concrete 10 inches or less in thickness including walls, slabs on grade, elevated slab and beam systems, columns and all other structural concrete 10 inches or less in thickness.

END OF SECTION 033000

SECTION 033500 - CONCRETE FINISHING

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. Finishing of concrete.
- 2. Floor surface treatment.

- B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for cast-in-place concrete formwork, form ties and form release agent.
- 2. Section 031500 "Concrete Joints and Accessories" for waterstops, premolded joint filler, sealant and neoprene bearing pads.
- 3. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete.
- 4. Section 033900 "Concrete Curing" for procedures for curing horizontal and vertical concrete surfaces.
- 5. Section 079200 "Joint Sealants" for sealants, sealers, and backing for sealing joints.

1.3 COORDINATION

- A. Coordinate Work of this Section with concrete placement and concrete curing.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information on sealer, curing compounds, curing papers, compatibilities, and limitations.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- C. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.

2. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit information on maintenance renewal of applied coatings.

1.7 QUALITY ASSURANCE

- A. Perform Work according to ACI 301 and 302.1.
- B. Maintain one copy of each standard affecting Work of this Section on Site.
- C. Provide the services of a qualified field representative of the manufacturer of sealer or hardener to instruct the contractor on the proper application of the product under prevailing job conditions.

1.8 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 and approved by manufacturer.

1.9 RESPONSIBILITY FOR CHANGING FINISHES

- A. Surface finishes specified for concrete to receive coatings or other finish materials are those required for the proper application of the products specified under other Sections. Where products different from those specified are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.
- B. Perform changes in finishes made to accommodate products different from those specified at no additional compensation. Submit proposed new finishes to Engineer for approval.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

- A. Temporary Heat: Maintain minimum ambient temperature of 50 degrees F.
- B. Ventilation: Sufficient to prevent injurious gases from temporary heat or other sources from affecting personnel or concrete.

PART 2 - PRODUCTS

2.1 COMPOUNDS - HARDENERS AND SEALERS

- A. Cementitious and component materials required for finishing concrete surfaces: As specified in Section 033000 "Cast-in-Place Concrete".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive Work of this Section.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FORMED SURFACES

- A. Form Removal: Conform to Sections 031000 "Concrete Forming and Accessories" and 033000 "Cast-In-Place Concrete".
- B. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.
- C. Off-Form Finish:
 - 1. Remove fins and other projections and fill tie cones and defects as specified in Section 031000 "Concrete Forming and Accessories" and 033000 "Cast-In-Place Concrete".
- D. Rubbed Finish:
 - 1. Immediately upon stripping forms and before concrete changes color, carefully remove fins with a hammer. While surface is still damp apply a thin coat of medium consistency neat cement slurry using bristle brushes to provide a bonding coat within pits, air holes or blemishes in parent concrete. Do not coat large areas of the surface with this slurry.
 - 2. Before slurry dries or changes color, apply a dry (almost crumbly) grout consisting of one volume cement to 1-1/2 volumes of clean masonry sand having a fineness modulus of approximately 2.25 and complying with gradation requirements of ASTM C144. Apply grout uniformly using damp (neither dripping wet nor dry) pads of coarse burlap approximately 6 inch square used as a float. Scrub grout into pits and air holes to provide a dense mortar in concrete imperfections to be patched.

3. Allow mortar to partially harden for one or two hours depending upon weather. If the air is hot and dry, keep surface damp during this period using a fine, fog spray. When grout has hardened sufficiently so it can be scraped from the surface with perpendicular edge of a steel trowel without damaging the grout in small pits or holes, cut off grout that can be removed with a trowel. Grout allowed to remain on surface too long will get too hard and will be difficult to remove.
4. Allow the surface to dry and rub it vigorously with clean dry burlap to completely remove dried grout. No visible film of grout should remain after this rubbing. Entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow grout to dry after it has been cut off with trowel so it can be wiped off clean with the burlap.
5. On the day following repair of pits, air holes, and blemishes, wipe surfaces clean with dry, used pieces of burlap containing old hardened mortar, which will act as a mild abrasive. After this treatment, there should be no built-up film remaining on the parent surface; if however a built-up film remains, use a fine abrasive stone to remove such material without breaking through original concrete surface film. Scrub lightly to remove excess material without working up a lather or mortar or changing concrete texture.
6. Follow final bagging or stoning operation with a thorough wash-down with stiff bristle brushes to remove extraneous materials from the surface. Spray surface with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after repair grout application.
7. Rubbed Finish application may be deleted by Engineer if unfinished concrete surface is of superior quality and without surface voids.

E. Abrasive Blast Finish:

1. Coordinate with Rubbed Finish application. Do not begin until materials applied during Rubbed Finish operation have cured or before concrete has reached minimum 7-day strength. Apply abrasive blast finish only where indicated on Contract Documents.
2. Prepare a sample area of minimum 4 feet high by 16 feet wide Blast Finish as directed by Engineer on a portion of new wall construction which will not be exposed in the final work. Sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials, and blasting techniques for selection by Engineer. Leave final accepted sample exposed until completion of all Blast Finish operations.
3. Perform Blast Finish operations meet regulatory agency requirements. Obtain required permits or licenses to perform the work.
4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.
5. Use an abrasive grit of proper type and gradation, as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:
 - a. Medium: Generally expose coarse aggregate to a 1/4 inch to 3/8 inch reveal.
6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure and blasting techniques required to match the approved mock-up.
7. Upon completion of Blast Finish operation, thoroughly flush finished surfaces with clean clear water to remove residual dust and grit.
8. After concrete has cured for a minimum of 28 days, apply a clear acrylic sealer as directed by manufacturer.

3.3 FLOORS AND SLABS

- A. Consider the potential for longer setting time in concrete containing fly ash or ground granulated blast furnace slag.
- B. Compact with internal vibrators as specified in Section 033000 "Cast-In-Place Concrete" and screed to established grades.
- C. Following screeding as specified above, float slabs as approved by the Engineer. Continue floating operation until sufficient mortar is brought to surface to fill voids. Test surfaces with a straightedge to detect and eliminate high and low spots. Do not overwork concrete as evidenced by excess water and fine material on its surface.
- D. Do not use "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate away from the surface and allowing a layer of mortar to accumulate on any slab finish. Do not dust surfaces with dry materials. Round off edges of slabs and tops of walls with a steel edging tool. Use steel edging tool with radius of 1/4 inch for slabs subject to wheeled traffic.
- E. Measure floor flatness the day after a concrete floor is finished and before the shoring is removed, in order to eliminate any effects of shrinkage, curling, and deflection.
- F. Finish Descriptions:
 - 1. Steel Trowel Finish:
 - a. Finish by screeding and floating with straightedges to bring the surfaces to indicated elevations. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float surface to a true and even plane with no coarse aggregate visible.
 - b. Apply sufficient pressure on wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks.
 - c. Trowel the surface again for the purpose of burnishing. Final troweling shall produce a ringing sound from the trowel.
 - d. Do not use dry cement or additional water in troweling.
 - 2. Wood Float Finish:
 - a. Finish by screeding with straightedges to bring the surfaces to indicated elevations.
 - b. Use a wood float to compact and seal surface. Remove laitance and leave a clean surface.
 - 3. Light Broomed Finish:
 - a. Steel trowel finish, as specified above, but omit final troweling and finish by drawing a fine-hair broom lightly across concrete surface.
 - b. Broom in direction and parallel to expansion joints, or in the case of inclined slabs, perpendicular to slope or as directed otherwise.
 - 4. Broomed Finish:

- a. Steel trowel finish, as specified above, but omit the final troweling
 - b. While the concrete is still soft enough, finish the surface with a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the Engineer.
5. Power Machine Finish:
- a. In lieu of hand steel trowel finishing, use an approved power machine for finishing concrete floors and slabs in accordance with directions of machine manufacturer and as approved by the Engineer.
 - b. Do not use a power machine until the concrete has attained necessary set to allow finishing without introducing high and low spots in the slab.
 - c. Hand steel trowel those areas of slabs not accessible to power equipment. Provide a final steel troweling done by hand over all areas.

3.4 APPLICATION

A. Floor Surface Treatment:

1. Apply sealer on floor surfaces in accordance with manufacturer's recommendations.

3.5 TOLERANCES

- A. Provide floors and slabs level with a tolerance of 1/8 inch when checked with a 10 foot straightedge, except where drains occur, in which case pitch floors to drains as indicated. When either of above criteria are not met, remove, grind, or make other corrections as directed by the Engineer, at no additional compensation.
- B. Measure floor flatness the day after a concrete floor is finished and before shoring is removed, in order to eliminate any effects of shrinkage, curling, and deflection. Support a 10 foot long straightedge at each end with steel gauge blocks whose thickness are equal to tolerance specified. Have no floor surface crowns so high as to prevent a 10 foot straightedge from resting on two end blocks, or low spots so that a third block of twice the tolerance in thickness can pass under the supported straightedge. Compliance with designated limits in four of five consecutive measurements will confirm compliance, unless obvious faults are observed. Make a check for adequate slope and drainage to confirm compliance.
- C. Maximum Variation of Surface Flatness for Exposed Concrete Floors and Slabs: 1/4 inch in 10 feet.
- D. Maximum Variation of Surface Flatness under Seamless Resilient Flooring: 1/4 inch in 10 feet.
- E. Measure for FF and FL tolerances for floors and slabs according to ASTM E1155, within 48 hours after slab installation.
- F. Finished Concrete:
 1. Exposed to View and Foot Traffic: FF 75 and FL 40.
 2. Correct slab surface when actual FF or FL number for floor installation measures less than required.

3.6 FIELD QUALITY CONTROL

A. Acceptance:

1. Areas requiring corrective Work will be identified by Engineer.
2. Correct defects in defined floor or slab by grinding or removal and replacement of defective Work.
3. Remeasure corrected areas by procedure as specified in TOLERANCES Article.

3.7 SCHEDULE OF FINISHES

A. Finish concrete in various specified manners either to remain as natural concrete or to receive an additional applied finish or material under another Section. Where products different from those specified are approved for use, comply with requirements of PART 1 Article entitled “Responsibility for Changing Finishes.”

B. Finish base concrete for following grouped conditions as scheduled in following Paragraphs and as further specified in this Section.

C. Exposed Exterior Concrete:

1. Concrete for exterior on stairs and other horizontal areas: Broomed finish, non-slip.
2. Tops of curbs and pads: Steel trowel finish.

D. Exposed Interior Concrete:

1. Exposed interior concrete including underside slabs, beams, walls, columns and stairs and sides of openings, beams, and stairs: Rubbed finish.
2. Concrete for interior walking surfaces, excluding stairs: Wood float finish.
3. Concrete for interior stairs and metal pan stairs: Light broomed finish, non-slip.

E. Concrete Associated with Structures:

1. Exposed exterior concrete excluding slabs and walking surfaces: Rubbed finish. Rub open tank walls above and to 1 foot below normal water line.
2. Walls of open topped tanks: Rubbed finish above and to 1 foot below normal water line. Off-form finish from 1 foot below normal water line to base of wall.
3. Concrete stairs, landings and platforms below normal water level in liquid retaining structures: Broomed finish, non-slip.
4. Concrete on which liquids flow or are contained: Steel troweled finish.
5. Concrete tank bottoms to be covered with grout: Broom finish as approved. Refer to Section 036000 “Grouting” for additional requirements.

F. Miscellaneous Concrete:

1. Ribbed Concrete: Off-form finish.
2. Concrete not exposed in finished work and not scheduled to receive an additional applied finish or material: Off-form finish at vertical surfaces, consolidate, and screed to grade at horizontal surfaces.

3. Concrete to have an abrasive blast finish: Refer to appropriate Paragraph in above PART 3 Article entitled "Formed Surfaces."

END OF SECTION 033500

SECTION 033900 - CONCRETE CURING

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: Initial and final curing of horizontal and vertical concrete surfaces.
- B. Related Requirements:
 - 1. Section 033000 “Cast-in-Place Concrete” for coordination of the Work of this Section with concrete placement, including Hot and Cold Weather and other environmental factors affecting concreting procedures.
 - 2. Section 033500 “Concrete Finishing” for surface finishing of concrete slabs and walls.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's information on curing compounds, mats, paper, sheets, and film, including compatibilities and limitations.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- C. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.
- D. Certifications:
 - 1. Certify curing compound is suitable for use in contact with potable water after 30 days and is non-toxic and free of taste or odor.

1.5 QUALITY ASSURANCE

- A. Perform Work according to ACI 301, 318, and 350.

- B. Maintain one copy of each standard affecting Work of this Section on Site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location.
 - 2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Membrane-Curing Compound, Type A:
 - 1. Comply with ASTM C309, Type 1D, Class A, containing no wax, paraffin or oil and be non-yellowing.
 - 2. Comply with Federal, State, and local VOC limits.
- B. Absorptive Mats, Type D:
 - 1. Description:
 - a. Material: Burlap-polyethylene (PE).
 - b. Minimum Weight: 9 oz./sq. yd.
 - c. Bonded to prevent separation during handling and placing.
 - 2. Description: Comply with ASTM C171.
- C. Water: Potable; not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to be cured.

3.2 APPLICATION

- A. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 degrees F at concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:
1. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling, or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit concrete surface to dry out at any time during curing period. Provide temperature of curing water within 20 degrees F of concrete temperature.
 2. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 3. Membrane Curing: Apply over entire concrete surface except as follows.
 - a. Do not apply curing compound on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where concrete finish requires an integral floor product.
 - b. Apply curing compound as soon as free water on the surface has disappeared and no water sheen is visible.
 - c. Do not apply after the concrete is dry or when curing compound can be absorbed into the concrete. Apply in compliance with manufacturer's recommendations.
- B. Specified Applications of Curing Methods:
1. Slabs for Liquid Retaining Structures: Water cure only.
 2. Slabs on Grade and Footings (not used to retain liquids): Water cure or sheet material cure.
 3. Structural Slabs (other than Liquid Retaining Structures): Water cure.
 4. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water cure.
 5. Formed Surfaces:
 - a. No curing, if nonabsorbent forms are left in place seven days.
 - b. Water cure if absorbent forms are used.
 - c. Water cure if forms are removed prior to seven days.
 - d. Sheet cure or membrane cure if forms are removed prior to seven days.
 - e. Water cure exposed horizontal surfaces of formed walls or columns for seven days or until next placement of concrete is made.
 6. Surfaces of Concrete Joints: Water cure or sheet material cure.
- C. Protect finished surfaces and slabs whenever ambient conditions of humidity, temperature, sunlight, and wind may result in the rapid evaporation of water from the concrete, to prevent checking and crazing, until the beginning of curing.

3.3 PROTECTION

- A. Do not permit traffic over unprotected surfaces.

- B. Reference Section 033000 “Cast-In-Place Concrete” for additional protection requirements.

END OF SECTION 033900

SECTION 036000 - GROUTING

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. Portland cement grout.
2. Cement grout.
3. Rapid-curing epoxy grout.
4. Nonshrink epoxy grout.
5. Nonshrink cementitious grout.

- B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories."
2. Section 033000 "Cast-in-Place Concrete."
3. Section 033200 "Concrete Reinforcing."
4. Section 051200 "Structural Steel Framing" for grout related to structural framing members.
5. Section 055000 "Metal Fabrications" for grout related to miscellaneous metals.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.

1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
2. Commercially manufactured nonshrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.
4. Concrete grout. Include data as required for concrete and for fiber reinforcement as delineated in Section 033000 "Cast-In-Place Concrete."

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.
- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- D. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each standard affecting Work of this Section on Site.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.
- C. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.
- D. Pre-installation Meeting: At least ten working days before grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Notify all parties involved with grouting, including the Engineer, of the meeting at least ten working days prior to its scheduled date.
- E. Services of Manufacturer's Representative: Provide services of a field technician of the nonshrink grout manufacturer [epoxy grout manufacturer] who has performed at least five projects of similar size and complexity during the last five years, to attend the pre-installation meeting, to be present for the initial installation of each type of nonshrink grout, and to correct installation problems.
- F. Field testing of concrete grout will be as specified for concrete in Section 033000 "Cast-In-Place Concrete."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location.
2. Provide additional protection according to manufacturer instructions.

1.7 AMBIENT CONDITIONS

- A. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.
- B. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

- A. Portland Cement: Comply with ASTM C150/C150M, Type I and II.
- B. Water:
 1. Potable.
 2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.
 - c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 1. Washed natural sand.
 2. Gradation:
 - a. Comply with ASTM C33/C33M.
 - b. Represented by smooth granulometric curve within required limits.
 3. Free from injurious amounts of organic impurities according to ASTM C40/C40M.
- D. Mix:
 1. Portland cement, sand, and water.
 2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID-CURING EPOXY GROUT

- A. Description:

1. High-strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
2. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids, and alkalis.

B. Performance and Design Criteria:

1. Compressive Strength:
 - a. 12,000 psi at seven days.
 - b. Comply with ASTM C579.
2. Minimum Tensile Strength:
 - a. 2,000 psi.
 - b. Comply with ASTM C307.
3. Coefficient of Expansion:
 - a. 30×10^{-6} inch per degree F.
 - b. Comply with ASTM C531.
4. Shrinkage:
 - a. None.
 - b. Comply with ASTM C827/C827M.

2.3 NONSHRINK EPOXY GROUT

A. Description:

1. Pre-proportioned, prepackaged, three-component, nonshrink epoxy grout, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate.

B. Performance and Design Criteria:

1. Minimum Compressive Strength:
 - a. 10,000 psi at seven days.
 - b. Comply with ASTM C579.
2. Coefficient of Expansion:
 - a. 30×10^{-6} inch per degree F.
 - b. Comply with ASTM C531.
3. Minimum Tensile Strength:
 - a. 1,800 psi.
 - b. Comply with ASTM C307.

C. Product: Provide one of the following or equal:

1. Masterflow 648 CP; by BASF Building Systems.
2. Five Star HP Epoxy Grout; by Five Stars Products, Inc.
3. Sikadur 42 Grout-Pak; by Sika Corp.
4. E3-G Epoxy Grout; by Euclid Chemical Co.

2.4 NONSHRINK CEMENTITIOUS GROUT

A. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C827/C827M.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C1107/C1107M for Grades B, C, D and CRD-C621 nonshrink grout:
 - a. Setting Time:
 - 1) Initial: Approximately two hours.
 - 2) Final: Approximately three hours.
 - 3) Comply with ASTM C191.
 - b. Maximum Expansion: 0.10 to 0.40 percent.
 - c. Minimum Compressive Strength:
 - 1) One-Day: 4,000 psi.
 - 2) Seven-Day: 7,000 psi.
 - 3) 28-Day: 10,000 to 10,800 psi.
 - 4) Comply with CRD-C621.

2.5 CONCRETE GROUT

A. Description: Conform to the requirements of Section 033000 "Cast-In-Place Concrete", except as follows. Proportion with Type II cement, coarse and fine aggregates, water, water reducing admixture, and air entraining agent to produce specified mix performance:

1. Average Strength (ASTM C579): 3,500 psi nominal strength.
2. Maximum Coarse Aggregate Size: 3/8-inch.
3. Minimum Cement Content: 540 lbs. per cubic yard.
4. Maximum Water to Cement Ratio: 0.45.
5. Maximum Slump: 5 inches.

B. Add synthetic reinforcing fibers as specified in Section 032000 "Concrete Reinforcing" to the concrete grout mix at the rate of 1.5 lbs. of fibers per cubic yard of grout. Add fibers from

manufacturer's pre-measured bags and according to manufacturer's recommendations to ensure complete dispersion of fiber bundles as single monofilaments within the concrete grout.

2.6 FORMWORK

- A. As specified in this Section and in Section 031000 "Concrete Forming and Accessories".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive grout.

3.2 PREPARATION

- A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by Engineer.
- B. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints, and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
 - 1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- C. Roughen concrete lightly, but not to interfere with placement of grout.
- D. Remove foreign materials from metal surfaces in contact with grout.
- E. Align, level, and maintain final positioning of components to be grouted.
- F. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface or other method acceptable to Engineer. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.
- G. Nonshrink epoxy grouts do not require saturation of concrete substrate. Do not wet concrete surfaces to receive nonshrink epoxy grout. Completely dry surfaces in contact with epoxy grout before grouting.
- H. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by Engineer. Grout voids created by the removal of shims, wedges, and blocks.

3.3 INSTALLATION - GENERAL

A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 031000 "Concrete Forming and Accessories".

B. Mixing - Portland Cement Grout:

1. Use proportions of two parts sand and one part cement, measured by volume.
2. Prepare grout with water to obtain consistency to permit placing and packing.
3. Mix water and grout in two steps:
 - a. Premix using approximately 2/3 of water.
 - b. After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
5. Do not add additional water after grout has been mixed.
6. Minimum Compressive Strength (ASTM C579):
 - a. In 48 hours: 2,400 psi.
 - b. In 28 days 7,000 psi.

C. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

E. Reflect existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

3.4 INSTALLATION - CONCRETE GROUT

- A. Inspect slabs finished under Section 033500 “Concrete Finishing” and scheduled to receive concrete grout. ICRI CSP 6 (medium scarification). Protect and keep the surface clean until placement of concrete grout.
- B. Remove debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Pressure wash the surface. Do not flush debris into tank drain lines.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout by use of saturated burlap bags, soaker hoses or ponding. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-inch thick cement paste.
- D. Place concrete grout to final grade using the scrapers of the installed mechanical equipment as a guide for surface elevation and to eliminate high and low spots. Unless specifically approved by the equipment manufacturer, do not use mechanical scraper mechanisms powered by their motors as a finishing machine or screed to push grout.
- E. Steel trowel finish as specified in Section 033500 “Concrete Finishing.” Cure the concrete grout as specified for cast-in-place concrete in Section 033000 “Cast-In-Place Concrete.”

3.5 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener, and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees F or above 90 degrees F.
- C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.3A. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Minimize ‘shoulder’ length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- F. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth top surface of grout in conformity with manufacturer's recommendations.
- G. Epoxy grouts are self-curing and do not require the application of water. Maintain formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1,000 psi or as recommended by manufacturer, whichever is longer.

- H. Provide grout control joints as indicated on Drawings.

3.6 SCHEDULE

- A. Use particular types of grout as follows:
 1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.
 2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long. Use at locations indicated to receive flowable (precision) nonshrink grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.
 3. Nonshrink Epoxy Grout: Use at locations specifically indicated to receive nonshrink epoxy grout.
 4. Cement Grout: Use where indicated.

END OF SECTION 036000

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SECTION 050519 - POST-INSTALLED ANCHORS AND REINFORCING BARS

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. Post-installed adhesive and expansion anchors for concrete substrates.
2. Post-installed reinforcing bar dowels using adhesive anchoring system.
3. Performance and proof testing of post-installed adhesive anchoring system for anchors and reinforcing bar dowels.

B. Related Requirements:

1. Section 033000 “Cast-In-Place Concrete” and related Sections for concrete, reinforcement, and accessories.
2. Various Sections in Division 05 related to metals.
3. Section 067413 “Fiberglass Reinforced Plastic Components”.
4. Various Sections in Divisions 22, 23, 26, and 27 related to facility utilities.
5. Various Sections in Divisions 40, 41, 43, and 46 related to process mechanical equipment.

1.3 ACTION SUBMITTALS

A. Post-Installed Expansion Anchors:

1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics for expansion anchors.
2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed expansion anchors installed into cracked concrete.
3. Installation Procedures: Submit procedures stating product proposed for use, and complete installation method.

B. Post-Installed Adhesive Anchoring System:

1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics, including temperature, humidity, and moisture limitations for adhesive anchoring system.

2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed adhesive anchoring system installed into cracked concrete.
3. Installation Procedures: Submit procedures stating method of drilling, product proposed for use, and complete installation method.

C. Post-Installed Adhesive Anchoring System Testing:

1. Equipment Data: Manufacturer's information for equipment to be used to conduct performance and proof tests on adhesive anchoring system. Submit diagrams showing geometry of performance and proof test equipment relative to the anchors and reinforcing bar dowels to be tested and calibration data for system of jacks and gauges, including:
 - a. Calibration: Conducted by a certified testing laboratory, of the complete performance and proof test assembly, together as a unit. Conduct assembly calibration within one month prior to conducting first test and present in the form of a plot of gauge pressure versus actual jack force.
 - b. Project Specific Diagram: Laboratory's proposed test equipment setups for monitoring elongation of anchors and reinforcing bar dowels during performance and proof tests. Meet the requirements of ASTM E488 and ASTM E3121. Have proposed test equipment completely independent of the jack and include a micrometer dial gauge capable of measuring anchor extension to nearest 0.001 inch having 3 inches of travel and be mounted on an adjustable tripod or other device with flexible extension arms or a goose neck to permit rapid alignment of the dial gauge axis with the axis of the anchor.

1.4 INFORMATIONAL SUBMITTALS

- A. Installation procedure: Submit installation procedure for post-installed adhesive anchoring system; including method of drilling.
- B. Certificates:
 1. Installer Qualifications for Adhesive Anchoring System: Submit installer and testing agency qualifications as stated in following Paragraph of this Article.
 2. Submit current International Code Council (ICC) Evaluation Service Reports (ESR) for expansion anchors and adhesive anchoring system, for installation into cracked concrete, as applicable, indicating conformance with current ICC Evaluation Service (ICC-ES) Acceptance Criteria.
- C. Qualification Data:
 1. Installer: Indicate manufacturer's training date and a list of personnel trained on installation of adhesive anchoring system.
 2. Testing Agency:
 - a. Laboratory: Meet requirements of ASTM E329. Prior to testing, submit qualifications of proposed testing laboratory for approval that includes:

- 1) Name and address.
 - 2) Names and positions of principal officers and name, position, and qualifications of responsible registered professional engineer in charge.
 - 3) List technical services provided, indicating external technical services to be provided by other organizations.
 - 4) Names and qualifications of the supervising laboratory technicians.
 - 5) Provide report prepared by laboratory evaluations authority when requested by Engineer.
 - 6) Submit as required above for other organizations that will provide external technical services.
- b. Include in submittal a list of five projects in which the laboratory has performed testing in accordance with ASTM E488. Include following information for each project:
- 1) Project name and location.
 - 2) Project Owner.
 - 3) Owner's representative including address and phone number.
 - 4) Brief description of work.
3. Submit qualifications of other laboratory or laboratories until approved.
- D. Performance and Proof Test Reports of Adhesive Anchoring System – Each Procedure: For each diameter of post-installed anchors and reinforcing bar dowels , for tests performed by manufacturer and witnessed by a qualified testing agency. Submit a report stamped and sealed by a Professional Engineer registered in State of Texas for each test procedure, including whether additional tests or design modifications are required. Based on the results of the reports, Engineer will determine if any additional tests or modifications to the design are required. Prepare each inspection report complying with ASTM E488 and ASTM E575 that includes:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing laboratory.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making the inspection or test.
 6. Designation of the work and test method.
 7. Complete inspection or test data.
 8. Test results and an interpretation of test results.
 9. Ambient conditions at time of testing.
 10. Comments or professional opinion on whether inspected or tested work complies with Contract Document requirements.
 11. Name and signature of laboratory inspector.
 12. Recommendations on retesting.
 13. Design data.
 14. Test reports.
 15. Field reports.
- E. Evaluation Reports: From ICC-ES for expansion anchors and adhesive anchoring system, for installation of post-installed anchors into cracked concrete, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.5 QUALITY ASSURANCE

- A. General: Coordinate with the work of other Sections, field verifying dimensions and work of other trades adjoining items of work before installing items specified in this Section.
- B. Representatives of post-installed anchor system manufacturer:
 - 1. Performance Testing: Be on site for installation of anchor and performance testing of adhesive anchoring system of their respective products system, subsystem, or component. Observe, guide, and provide instruction on Contractor's assembly, erection, installation or application procedures during the drilling, placement, injection and testing. Inspect, check, and make adjustments as required for the product to function as warranted by the manufacturer and as necessary to furnish the Manufacturer's Certification of Proper Installation.
 - 2. Proof Testing: Be on site periodically for assistance during installation and testing/inspection of their respective products system, subsystem, or component. Observe, guide, and provide instruction on Contractor's assembly, erection, installation or application procedures during the drilling, placement, injection, and testing. Inspect, check, and make adjustments as required for the product to function as warranted by the manufacturer and as necessary to furnish the Manufacturer's Certification of Proper Installation.
- C. Adhesive Anchoring System:
 - 1. Installer Training: Conduct thorough training by the manufacturer or the manufacturer's representative. Training shall consist of the complete installation process for post-installed anchors and reinforcing bar dowels, including but not limited to:
 - a. Tool selection.
 - b. Hole drilling procedure.
 - c. Hole preparation and cleaning techniques.
 - d. Adhesive injection technique and dispenser training and maintenance.
 - e. Anchor preparation and installation.
 - f. Reinforcing bar dowels preparation and installation.
 - g. Proof loading and torqueing.
 - h. Temperature, humidity, and moisture limitations.
 - i. Working time limitations.
 - j. Setting time.
 - 2. Include training for anchors and reinforcing bar dowels installed horizontally or upwardly inclined to support sustained tension loads. Install horizontally or upwardly inclined anchors and reinforcing bar dowels by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
 - 3. Manufacturer's Certificate of Proper Installation: Submit upon completion of work, for the post-installed anchors and reinforcing bar dowels, including non-production and production anchors, and reinforcing bar dowels.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Handle materials with cranes or derricks. Do not dump material off transportation vehicles or handle in ways that will cause damage.
- C. Store materials elevated above grade and block up so they will not become bent or otherwise damaged.
- D. Repair items that have become damage or corroded to satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 EXPANSION ANCHORS

- A. Fastening to Concrete Substrate: Zinc plated carbon steel wedge type anchors, complete with zinc plated nuts and washers, unless otherwise noted.
- B. Submerged or Weather Exposed Substrates: ASTM A276 Type 316 stainless steel wedge type anchors, complete with Type 316 stainless steel nuts and washers, unless otherwise noted.
- C. Meet ICC ES AC01 or ICC ES AC193.
- D. Length: When length or anchor embedment is not indicated, provide length sufficient to place the wedge and expansion cone portion of the anchor at least 1 inch behind concrete reinforcing steel.
- E. Basis-of-Design:
 - 1. Anchorage designs indicated are based on Hilti, Kwik-Bolt TZ2, unless otherwise noted.
 - 2. Acceptable Anchors: Hilti Kwik-Bolt TZ2; Simpson Strong-Tie Strong Bolt 2 Wedge Anchor; DeWalt Power-Stud+ SD1; or equal.

2.2 ADHESIVE ANCHORING SYSTEM

- A. Fastening to Concrete Substrate: Manufactured system consisting of post installed threaded rods, nuts, washers, other anchoring hardware, and chemical dispenser for installation in hammer drilled holes.
 - 1. Anchors: Meet ICC ES AC308.
 - 2. Injection Adhesive: Two-component epoxy system consisting of a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate.
 - 3. Adhesive Cartridge: Side-by-side design to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
 - 4. Anchor: Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.

- a. Basis-of-Design:
 - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
 - 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.
- 5. Reinforcing Bar Dowels: Reinforcing bar, per Section 032000 “Concrete Reinforcing”.
 - a. Basis-of-Design:
 - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
 - 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

2.3 PERFORMANCE REQUIREMENTS

- A. Performance: design anchors and reinforcing bar dowel anchorage for all anticipated loads and load combinations per ASCE/SEI 7 including omega-naught (Ω_o) factors as applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install anchoring system in strict compliance with manufacturer's published installation instructions and approved Shop Drawings. Comply with recommended surface preparation, temperature, and moisture of substrate and ambient conditions.
 - 2. Coordinate installation with Special Inspector.
 - 3. Use drill bit of correct diameter and drill to required depth using rotary impact type hammer drills with carbide-tipped bits.
 - 4. Drill holes perpendicular to concrete surface, unless otherwise indicated.
 - 5. Use oil free compressed air to blast out loose particles and dust from drilled holes.
- B. Expansion anchors:
 - 1. Check expansion anchors for tightness a minimum of 24 hours after initial installation.
- C. Adhesive anchoring system:
 - 1. Perform installation only by personnel trained in anchor installation and having certification required in PART 1 - GENERAL.
 - 2. Inject adhesive and install anchors and reinforcing bar dowels that are clean and free of dirt, oil, grease, ice or other deleterious material which would reduce bond.

3.2 TESTING OF ADHESIVE ANCHORING SYSTEM

A. Performance Testing:

1. Prior to demolition of existing work at locations of concrete to be removed, conduct performance testing of approved adhesive anchoring system at locations indicated.
2. Locate existing reinforcing bars with the use of a reinforcing bar locator prior to installation of post-installed anchors and reinforcing bar dowels to be used for performance testing. Mark existing reinforcing bars on concrete indicating spacing and direction within test area. Do not cut existing reinforcing bars without prior approval by Engineer.
3. Use post-installed anchors and reinforcing bar dowels matching those of the approved adhesive anchoring system with the embedment length indicated. In the event an alternate adhesive anchoring system is approved, the embedment length will be determined by Engineer.
4. Design Strength of Existing Concrete: 3,000 psi at 28 days in.
5. Install and test post-installed anchors and reinforcing bar dowels, as indicated.
 - a. For each diameter of post-installed anchors install and test one group of five anchors.
 - b. For each diameter of post-installed reinforcing bar dowels install and test one group of five reinforcing bar dowels.
 - c. Perform static tensile test in accordance with ASTM E488 using defined incremental load application and failure criteria. Test to failure.
 - d. Test Results: For each of the one group of five anchors and reinforcing bar dowels, test three and average the results. If the result of any one test in a group varies by more than 15 percent from the group average, perform two additional tests at locations determined by Engineer. Average the five test results.
6. Advise Engineer at least 14 working days prior to Performance Testing.
7. Do not use post-installed anchors and reinforcing bar dowels installed for performance testing as part of production anchors and bars.
8. Do not demolish existing construction or perform new work until Performance Testing is complete and approved by Engineer.

B. Proof Testing:

1. Perform proof tests in accordance with ASTM E488.
2. During the progress of the work perform periodic proof test of post-installed anchors.
 - a. Threaded Rod Size: 3/4 inch diameter.
 - b. Post-installed Anchors: During progress of the work, randomly chose for Proof Testing 5 percent of each anchor diameter, embedment length, and adhesive bonding material system. Select test anchors at random. Test the anchors for the static tension test only, to the allowable test load of 10,000 pounds for 3/4 inch diameter.
3. During progress of the work, perform periodic proof test of post-installed reinforcing bar dowels.
 - a. Bar sizes: #4, #5, #6, #7, #8.

- b. Initial Reinforcing Bar Dowel Test Group: During progress of the work, randomly select five post-installed reinforcing bar dowels, for Proof Testing. Select from first 50 post-installed reinforcing bar dowels installed.
 - c. Subsequent Reinforcing Bar Dowel Test Groups: In addition, randomly select and test one post-installed reinforcing bar dowel from every 20 post-installed bars installed of remaining post-installed bars.
4. Post-installed Reinforcing Bar Dowels: Test for static tension only to Allowable Test Load indicated in Table 1.

TABLE 1

Post-installed Reinforcing Bar Dowels Test Loads

<u>Rebar Size</u>	<u>Yield Strength</u>	<u>Allowable Test Load</u>
#4	12,000 lbs	4,800 lbs
#5	18,600 lbs	7,440 lbs
#6	26,400 lbs	10,560 lbs
#7	36,000 lbs	14,400 lbs
#8	47,400 lbs	18,980 lbs

NOTE: Test loads are based on Hilti. Engineer may modify Table values based on approved adhesive anchoring system.

3.3 TEST FAILURE - ADHESIVE ANCHORING SYSTEM

- A. Failure Defined: Observance of any one or any combination of failure modes in ASTM E488.
- B. Performance Testing: If results show a failure of the adhesive system, not yielding of anchor or reinforcing bar dowel, Engineer will require greater embedment, changes in installation technique, or require the use of another adhesive anchoring system, at no additional cost to Owner.
- C. Proof Testing of Anchors: If any of the tested anchors failed, perform two additional tests on adjacent untested anchors, one each side. Continue additional tests until no more tests fail, or all anchors installed that day are tested. Engineer may require greater embedment, changes in installation technique, or require the use of another adhesive anchoring system, at no additional cost to Owner.
- D. Proof Testing of Reinforcing Bar Dowels: If the bond strength of a post-installed reinforcing bar dowel falls below the Allowable Test Load indicated in Table 1, Engineer may require greater embedment, changes in installation technique, or require the use of another adhesive anchoring system, at no additional cost to Owner.
- E. If installations fail to produce the required strength performance, Engineer will require additional post-installed anchors and require modified or enlarged base plates or additional

metal connecting pieces or reinforcing bar dowels and additional reinforced concrete to meet the required design strength. Perform this additional work and additional tests to correct deficient installations, at no additional cost to Owner.

3.4 REPAIRS

- A. At testing completion, repair damaged concrete, post-installed anchors, reinforcing bar dowels and other damaged construction as required to match conditions prior to testing.
- B. Repair in accordance with provisions of Section 030130.71 “Modifications to Existing Concrete”, including but not limited to:
 - 1. Saw cutting and removal of damaged, loose, or unsound concrete.
 - 2. Removal of damaged anchors and reinforcing bar dowels.
 - 3. Cleaning and preparing concrete surface and reinforcing bar dowels.
 - 4. Place new repair material.
 - 5. Install new anchors or reinforcing bar dowels to replace anchors or reinforcing bar dowels that are found to be unacceptable or deficient.
 - 6. Perform repairs at no additional cost to Owner.

END OF SECTION 050519

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SECTION 051200 - 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. Prefabricated building columns.
3. Field-installed shear connectors.
4. Delegated Design.

- B. Related Requirements:

1. Section 036000 "Grouting" for grouting.
2. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
3. Section 099679 "Atmospheric Protection and Plant Service Areas Coating" for surface-preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
 1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
 2. Welded built-up members with plates thicker than 2 inches.
 3. Column base plates thicker than 2 inches.
- D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

- E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

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: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Erection drawings, detailed shop drawings, anchor bolt placement drawings, schedules, and data for all structural steel
 - 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 3. Include embedment Drawings.
 - 4. 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.
 - 5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 - 6. Identify members and connections of the Seismic-Load-Resisting System.
 - 7. Indicate locations and dimensions of protected zones.
 - 8. Identify demand critical welds.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint qualified by testing, including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand critical welds.

1.7 DELEGATED DESIGN SUBMITTAL

- A. Delegated Design Submittal: For structural-steel connections indicated to comply with design loads, include calculations signed and sealed by the qualified professional engineer responsible for their preparation.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For erector and fabricator.
- 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, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
- F. Survey of existing conditions.

1.9 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 (AC 172).
- B. Erector Qualifications: A qualified erector who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 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.
- E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.10 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 F1852 fasteners and for retesting fasteners after lubrication.
- C. Store welding electrodes as recommended by the manufacturer and to avoid damage by moisture or contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer, as defined in Sections 013300 "Submittal Procedures" and 014000 "Quality Requirements", to submit the items listed in the DELEGATED DESIGN SUBMITTALS Article.
- B. Connections: Provide details of connections not fully detailed on the Drawings, including comprehensive engineering calculations by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated. Provide connections as shown in Table 10-1, Part 10 of the AISC Steel Construction Manual, unless otherwise noted.
 1. Select and complete connections using schematic details indicated and AISC 360.
 2. Use Allowable Stress Design; data are given at service-load level.
- C. Design connections for diagonal bracing for tension and compression forces noted on Drawings. Indicate work points for bracing, unless otherwise approved. Bolt or weld shop connections and bolt field connections.
- D. Moment Connections: Type PR, partially and Type FR, fully restrained.
- E. Construction: Combined system of moment frame, braced frame, and shear walls.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles, M, S-Shapes: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M.
- D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, Grade 50.
- E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B, structural tubing.
- F. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A847/A847M, structural tubing.
- G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
 - 1. Finish: Galvanized.
- H. Steel Castings: ASTM A216/A216M, Grade WCB with supplementary requirement S11.
- I. Steel Forgings: ASTM A668/A668M.
- J. Welding Electrodes: AWS A5.1, E70XX.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade C, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F959, Type 325, compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers with plain finish.
 - 1. Direct-Tension Indicators: ASTM F959, Type 490, compressible-washer type with plain finish.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- D. Threaded Rods: ASTM A36/A36M.
 - 1. Nuts: ASTM A563 heavy-hex carbon steel.
 - 2. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 3. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

- E. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035.
- F. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.
- G. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018.

2.4 PRIMER

- A. Primer: Comply with Section 099679 "Atmospheric Protection and Plant Service Areas Coating".
- B. Primer: SSPC-Paint 25, Type I, zinc oxide, alkyd, linseed oil primer.
- C. Primer: SSPC-Paint 25 BCS, Type I, zinc oxide, alkyd, linseed oil primer.
- D. Primer: SSPC-Paint 23, latex primer.
- E. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- F. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel 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, mechanically thermal cut, 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 according to SSPC-SP 3, "Power Tool Cleaning."

- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. 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.
- 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.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M 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 AISC 303 for mill material.

2.7 PREFABRICATED BUILDING COLUMNS

- A. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.
- B. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E119.
 - 1. Fire-Resistance Rating: As indicated.

2.8 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. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
 3. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 4. SSPC-SP 8, "Pickling."
- C. Priming: Immediately after surface preparation, apply primer according to 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.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to 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.

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. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction 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 according to AISC 303 and 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. Grout in accordance with Section 036000 "Grouting".
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- 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.
 - 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 Engineer. 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.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work. Do no welding when surfaces are wet, exposed to rain, snow or wind, or when welders are exposed to inclement conditions that will hamper good workmanship.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
- C. Assign each bolting crew and each welder an identification mark. Make this mark at each completed connection with a paint stick.
 - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

- A. Allow the Engineer or testing agency engaged by Owner free access to the work. Notify the Engineer in writing 4 working days in advance of high strength bolting and field welding operations, including pre-installation verification of high strength bolt assemblies. The Engineer will inspect the following or Owner will engage a testing agency.
 - 1. Structural-steel materials and inspect steel frame joint details.
 - 2. Weld materials and inspect welds.
 - 3. Connection materials and inspect high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Welded connections will be visually inspected according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at Owner's testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165.

- 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.
- D. In addition to visual inspection, field-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
- 1. Bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Testing according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.7 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: 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.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 051200

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SECTION 055000 - METAL FABRICATIONS

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 framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Steel beams, not included in Section 051200.
4. Steel angles.
5. Steel lintels.
6. Steel support brackets.
7. Steel base plates for other than structural steel or equipment.
8. Steel holddown straps and lugs.
9. Steel splice plates.
10. Steel subframing at roof openings.
11. Shelf angles.
12. Miscellaneous items fabricated from steel aluminum or stainless steel.
13. Aluminum beams.
14. Aluminum angles.
15. Aluminum closure angles.
16. Aluminum grates.
17. Aluminum diamond plate and floor plate.
18. Aluminum stop plates.
19. Aluminum stair nosings.
20. Aluminum stair treads
21. Aluminum nosing.
22. Steel pipe pieces for sleeves.
23. Metal ladders.
24. Metal ships' ladders and pipe crossovers.
25. Metal floor plate and supports.
26. Loose bearing and leveling plates for applications where they are not specified in other Sections.

- B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 036000 "Grouting" for non-shrink grout.
3. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for anchors in various substrates.
4. Section 051200 "Structural Steel Framing" for structural steel components.
5. Section 055313 "Bar Gratings" for various types of bar grating assemblies.
6. Various Sections in Divisions 40 - 46 for process mechanical work scopes.

1.3 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 metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 2. Prefabricated building columns.
 3. Metal nosings and treads.
 4. Paint products.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 1. Steel framing and supports for mechanical and electrical equipment.
 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 3. Prefabricated building columns.
 4. Shelf angles.
 5. Metal ladders.
 6. Metal ships' ladders and pipe crossovers.
 7. Metal floor plate and supports.
 8. Loose steel lintels.
 9. Miscellaneous steel items.
 10. Miscellaneous aluminum items.

11. Miscellaneous stainless steel items.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by aluminum, steel and stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
 1. Certify that welders have been qualified under AWS, within previous 12 months, to perform welds required under this Section.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless steel."
- C. Evaluation Reports: Post-installed concrete anchors, from ICC-ES for expansion anchors and adhesive anchor system, for installation into cracked concrete, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

- B. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Uniform Load: 100 lbf/sq. ft.
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Wide Flange Shapes: ASTM A992.
- C. Steel Other Shapes, Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Stainless steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 316.
- E. Stainless steel Bars and Shapes: ASTM A276, Type 316.
- F. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- G. Rolled-Stainless Steel Floor Plate: ASTM A793.
- H. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallurgically bonded to steel.
- I. Steel Tubing: ASTM A500/A500M, Grade B cold-formed steel tubing.
- J. Steel Pipe: ASTM A53/A53M, Type S Grade B Standard Weight (Schedule 40) unless otherwise indicated.
- K. Zinc-Coated Steel Wire Rope: ASTM A741.
 - 1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- L. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

- M. Aluminum Extruded Pipe: ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated.
- N. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- O. Aluminum Extrusions: ASTM B221, Alloy 6061 T6.
- P. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- Q. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- R. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
- S. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).
- T. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.
- U. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).
- V. Gray Iron Castings: ASTM A48, Class 35.
- W. Ductile Iron Castings: ASTM A536, Grade 65-45-12.
- X. Stainless steel Bolts: ASTM F593, Type 316.
- Y. Stainless steel Nuts: ASTM F594, Type 316.
- Z. Carbon Steel Bolts and Studs: ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)
- AA. High Strength Steel Bolts, Nuts and washers: ASTM F3125, Grade A325 (mechanically galvanized per ASTM B695, Class 50, where noted).
 - 1. Elevated Temperature Exposure: Type I.
 - 2. General Application: Type I or Type II.
- BB. Galvanizing: ASTM A123, Zn w/0.05 percent minimum Ni.
- CC. Galvanizing, hardware: ASTM A153, Zn w/0.05 percent minimum Ni.
- DD. Galvanizing, anchor bolts: ASTM F2329, Zn w/0.05 percent minimum Ni.
- EE. Welding electrodes, steel: AWS A5.1 E70xx.

2.3 FASTENERS

- A. Unless otherwise noted, provide steel machine bolts for the connection of carbon steel or iron; galvanized steel or stainless steel machine bolts for the connection of galvanized steel or iron; and stainless steel machine bolts for the connection of aluminum or stainless steel.

- B. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum.
 - 2. Provide stainless steel fasteners for fastening stainless steel.
 - 3. Provide stainless steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- D. Mechanically Galvanized Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM F3125, Grade A325, Type 3; with hex nuts, ASTM A563, Grade C3; and, where indicated, flat washers.
- E. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.
- F. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Provide standard headed bolts with heavy hex nuts and Grade A washers.
 - 2. Where galvanized anchor bolts are indicated or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, galvanize in accordance with ASTM F2329.
- G. Machine bolts and nuts conforming to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers, and related appurtenances shall be Type 316 stainless steel.
- H. Toggle Bolts: Hilti, Toggler Bolt or equal.
- I. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.
- J. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47 malleable iron or ASTM A27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.
- K. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts

2.4 MISCELLANEOUS ALUMINUM

- A. Miscellaneous Aluminum: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Weld on unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous Aluminum Items: Beams, angles, closure angles, grates, floor plates, stop plates, stair nosings, and other miscellaneous aluminum indicated and not otherwise specified.
- D. Angle Frames for Roof Hatches, Beams, Grates, and Similar Items: Complete with welded strap anchors attached.
- E. Stair Treads for Aluminum Stairs: As specified for grating and having cast abrasive non-slip nosing as approved.
- F. Aluminum Nosing at Concrete Stairs: Furnish with wing type anchors and flat head stainless steel machine screws, 12 inches on center. Provide nosing at concrete ladder openings. Single piece nosing for each step extending to within 3 inches at each side of stair. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.
 - 1. Basis-of-Design: Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal.
- G. Aluminum Finishes:
 - 1. Mill Finish: Have a cleaned and degreased mill finish on other aluminum items.

2.5 MISCELLANEOUS STEEL

- A. Miscellaneous Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal thread on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

- C. Miscellaneous Steel Items: Beams, angles, lintels, metal stairs detailed on the Drawings, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holddown straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel indicated and not otherwise specified.
- D. Structural steel angle and channel door frames: Galvanized. Fabricated with not less than three anchors on each jamb.
- E. Steel pipe pieces for sleeves, lifting attachments and other functions: Schedule 40 pipe unless otherwise indicated. Wall and floor sleeves, of steel pipe: Provide welded circumferential steel waterstops at mid-length.
- F. Lintels, relief angles or other steel supporting masonry or embedded in masonry: Galvanized.
- G. Steel Finish Work: Thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter. Provide one shop coat of primer compatible with finish coat after fabrication but before shipment. Omit paint within 3 inches of proposed field welds. Apply paint to dry surfaces and be thoroughly and evenly spread and well worked into joints and other open spaces.
- H. Galvanizing, where required: Use hot-dip zinc process after fabrication, coating not less than 2 oz/sq.ft. of surface.

2.6 MISCELLANEOUS STAINLESS STEEL

- A. Miscellaneous Stainless Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints, jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Beams, angles, bar racks, and other miscellaneous stainless steel.

2.7 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099679 “Atmospheric Protection and Plant Service Areas Coating”.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.8 CASTINGS:

- A. General: Good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes, and other defects. Thoroughly clean castings to remove foreign matter, and deleterious films. Castings will be subjected to a hammer inspection in the field by the Engineer. Damaged castings may be rejected and replaced at no cost to the Owner.
- B. Matching Surfaces: Machine to a true plane surface allowing contact surfaces to seat without rocking. Provide allowances in patterns so specified thickness is not reduced to obtain finished surfaces. Castings will not be acceptable if actual weight is less than 95 percent of theoretical weight computed from dimensions. Provide facilities for weighing castings in the presence of the Engineer.

2.9 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/4 inch by 1 inch, with a minimum 6 inch embedment and 1 1/2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with primer specified in Section 099679 "Atmospheric Protection and Plant Service Areas Coating" where indicated.

2.11 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
 1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. Galvanize shelf angles located in exterior walls.

- C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.12 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches apart, unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 1-inch- diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch in least dimension.
8. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
9. Galvanize ladders, including brackets.
10. Prime exterior ladders, including brackets and fasteners.

C. Aluminum Ladders:

1. Space siderails minimum 18 inches apart, unless otherwise indicated.
2. Siderails: Continuous aluminum bars Schedule 80, 1-1/2 inch I.D. continuous extruded aluminum pipe.
3. Rungs: Solid extruded-aluminum tubes, 3/4 inch diameter.
4. Fit rungs in centerline of siderails; fasten as indicated.
5. Wall Support Brackets: Type 316 stainless steel spaced 4 feet on center with Type 316 stainless steel fasteners. Fasten side rails to floor with 1/2 inch diameter Type 316 stainless steel expansion anchors.
6. Platforms: Fabricate from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.
7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets.
8. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

D. Stainless Steel Ladders:

1. Material: Fabricate from Type 316 stainless steel.

2. Siderails: Continuous 1/2-inch by 2-1/2-inch, spaced at minimum of 18 inches unless otherwise indicated.
3. Rungs: 3/4 inch diameter stainless steel rods spaced 12-inches on center.
 - a. Fit rungs in centerline of siderails; fasten as indicated.
4. Wall Support Brackets: Type 316 stainless steel spaced 4 feet on center with Type 316 stainless steel fasteners. Fasten side rails to floor with 1/2 inch diameter Type 316 stainless steel expansion anchors.
5. Platforms: Fabricate from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.

2.13 LADDER SAFETY SYSTEM

- A. Provide a ladder safety system at each ladder more than 20 feet high and as indicated.
 1. Provide an aluminum or stainless steel vertical rigid rail, rail brackets for continuous travel, rail extension, stainless steel mounting hardware and fasteners, two non-corrosive metal sliding fall prevention devices, two full body harnesses with "D" rings, accessories and other materials required for complete installation and operation of ladder safety system in accordance with manufacturer's recommendations.
 2. Provide 36 inch minimum height permanent aluminum or stainless steel rail extension compatible with sliding fall prevention device to ensure worker is attached to ladder safety system while mounting and dismounting from a platform or landing. Provide removable ladder extensions at manholes, hatches, and roof scuttles. Provide stainless steel hardware and fasteners, accessories, and other materials required for complete installation to ladders in accordance with manufacturer's recommendations.
 3. Provide alignment between successive pieces of rail. Provide allowance for expansion and contraction on long runs.
 4. In addition to "D" ring used for attachment to sliding fall prevention device, provide harnesses with at least two "D" rings for attachment of safety straps and lanyards.
 5. Attach ladder safety system to installed ladders. Provide sliding fall prevention device allowing worker to climb up and down using both hands, and move freely up and down the rail with worker in normal climbing position. Do not allow connection between sliding fall prevention device and harness attachment point to exceed 9 inches. Fabricate ladder safety system to stop the fall of a worker independently from offset ladders, platforms, or safety cages.
 6. Conform to OSHA Regulation 1910.21 for ladder safety system. Rope or cable systems will not be allowed.
 7. Basis-of-Design - Ladder Safety System: Saf-T-Climb by Honeywell International Inc.; Railok 90 by 3M Fall Protection; GlideLoc System by Honeywell International Inc.; or equal.
 8. Provide ladder safety post extensions on fixed ladders 20 feet or less in height located below hatches and roof scuttles and as indicated. Locking aluminum telescoping safety post extension in its vertical position and extend a minimum of 36-inches above opening and be secured to ladder rungs with stainless steel fasteners and brackets.
 - a. Basis-of-Design: Ladder UP Safety Post, Model LU-4 by Bilco Co.; Series L1E Safety Extension by Halliday Products; or equal.

2.14 COVER PLATE

- A. Fabricate aluminum diamond plate and floor plate having a minimum thickness of 3/8 inch. Fabricate frames and supports of aluminum construction. Fastening devices and hardware shall be Type 316 stainless steel. Plates shall have a mill finish.
- B. Provide aluminum angle supports as indicated.
- C. Include aluminum angle stiffeners, and fixed and removable sections as indicated.
- D. Provide flush stainless steel bar drop handles for lifting removable sections, one at each end of each section.

2.15 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize miscellaneous steel trim.

2.16 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.

2.17 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles, shapes, and plates of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings of 8 inches unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with primer specified in Section 099679 "Atmospheric Protection and Plant Service Areas Coating".

2.18 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.19 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.20 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products. Limit maximum nickel (Ni) content of galvanizing zinc to 0.05 percent.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2.21 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 03 and Division 04 respectively. Install items to be attached to concrete or masonry after such work is completed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding after welding.
- C. Clean and repair, after installation, zinc coating which has been burned by welding, abraded, or otherwise damaged. Thoroughly clean damaged area and remove all traces of welding flux and loose or cracked zinc coating prior to painting. Paint the cleaned area per the requirements of ASTM A780.
- D. Install specialty products in accordance with the manufacturer's recommendations.

- E. Weld headed anchor studs in accordance with manufacturer's recommendations.
- F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- G. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- H. Field Welding: Comply with the following requirements:
 - 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- K. Corrosion Protection: Coat concealed surfaces of aluminum and steel that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Aluminum Contacting a Dissimilar Metal: Apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
 - 2. Aluminum Contacting Masonry or Concrete: Apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
 - 3. Aluminum Contacting Wood: Apply two coats of aluminum metal and masonry paint to the wood.
 - 4. Steel Contacting Exposed Concrete or Masonry: Apply heavy bitumastic troweling mastic.
 - 5. Between aluminum stair treads, and steel supports, insert 1/4 inch thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

- B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING PIPE GUARDS

- A. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch bolts at each pipe guard. Mount pipe guards with top edge 26 inches above driving surface.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099679 “Atmospheric Protection and Plant Service Areas Coating”.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION 055000

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SECTION 055119 - METAL GRATING STAIRS

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. Industrial Class stairs with aluminum-grating treads.
2. Aluminum railings and guards attached to metal stairs.
3. Aluminum handrails attached to walls adjacent to metal stairs.
4. Delegated Design.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs, railings, and guards.
 1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, blocking for attachment of wall-mounted handrails, and items with integral anchors, that are to be embedded in concrete or masonry.
 2. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.
- D. Schedule installation of railings and guards so wall attachments are made only to completed walls.
 1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For metal grating stairs and the following:
 1. Gratings.

2. Woven-wire mesh.
3. Welded-wire mesh.
4. Shop primer products.
5. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

1.5 DELEGATED DESIGN SUBMITTALS

- A. For stairs, railings, and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Engineer Qualifications: Professional Engineer currently registered in the State of Texas.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 2. Protect steel members and packaged materials from corrosion and deterioration.
 3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

- a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, railings, and guards, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Uniform Load: 100 lbf/sq. ft.
 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 5. Limit deflection of treads, platforms, and framing members to $L/360$.
- C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.
- D. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. Component Importance Factor: See Drawing S-1.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Aluminum Plates, Shapes, and Bars: Aluminum Allow 6061-T6.
- C. Rolled-Aluminum Floor Plate: Aluminum Allow 6061-T6.
- D. Aluminum Bars for Grating Treads: ASTM B221 extruded aluminum, alloys as follows:
 - 1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
 - 2. 6061-T1, for grating crossbars.
- E. Aluminum Tubing for Railings and Guards: Aluminum Alloy 6061-T6.
- F. Aluminum Pipe for Railings and Guards: Aluminum Alloy 6061-T6.
- G. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

2.3 FASTENERS

- A. General: Provide Type 316 stainless steel fasteners.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.
- C. Bolts and Nuts: Regular hexagon-head bolts, Type 316 stainless steel; with hex nuts, and, where indicated, flat washers.
- D. Anchor Bolts: Type 316 stainless steel, of dimensions indicated; with nuts, and, where indicated, flat washers.
- E. Post-Installed Anchors: Adhesive anchors, with Type 316 stainless steel threaded rods, capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for exterior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply 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. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish # 3 - Partially dressed weld with spatter removed.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that are exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF ALUMINUM-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:

1. Fabricate stringers of aluminum plates or channels.
 - a. Stringer Size: As indicated on Drawings.
 - b. Provide closures for exposed ends of channel stringers.
 2. Construct platforms and tread supports of aluminum plate or channel headers and miscellaneous framing members as indicated on Drawings.
 - a. Provide closures for exposed ends of channel framing.
 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.
 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.
 - a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
1. Fabricate treads and platforms from pressure-locked aluminum grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c.
 2. Fabricate treads and platforms from pressure-locked aluminum grating with openings in gratings no more than 5/16 inch in least dimension.
 - a. Surface: Cast aluminum with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both
 3. Fabricate grating treads with cast-abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections.
 - a. Secure treads to stringers with bolts.
 4. Fabricate grating platforms with nosing matching that on grating treads.
 - a. Secure grating to platform framing by welding or with bolts.
- D. Risers: Open.
- E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.
1. Material and Finish: Aluminum plate to match finish of other steel items.
 2. Fabricate to dimensions and details indicated.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Comply with minimum design and detail requirements on Drawings (Standard Structural Details) SZ series.
- B. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 3. Weld all around at connections, including at fittings.
 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 5. Obtain fusion without undercut or overlap.
 6. Remove flux immediately.
 7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #3 - Partially dressed weld with spatter removed as shown in NAAMM AMP 521.
- C. Form changes in direction of railings and guards as follows:
1. As detailed.
 2. By bending or by inserting prefabricated elbow fittings.
 3. By flush bends or by inserting prefabricated flush-elbow fittings.
 4. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
 5. By inserting prefabricated elbow fittings.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.
1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing and guard members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
1. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- G. Connect posts to stair framing by direct welding unless otherwise indicated.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
 4. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

- I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.
 1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

- A. Finish of aluminum stairs shall be anodized finish, see Specification 055000 “Metal Fabrications”

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
 1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
 1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
 1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.
 - a. Clean bottom surface of baseplates.
 - b. Set aluminum-stair baseplates on wedges, shims, or leveling nuts.
 - c. After stairs have been positioned and aligned, tighten anchor bolts.
 - d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
 - e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

- 1) Neatly finish exposed surfaces; protect grout and allow to cure.
 - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints.
1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 3. Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to aluminum by welding or bolting to aluminum supporting members.
 - b. Anchor handrail and guard ends to concrete and masonry with aluminum round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.
- B. Attach handrails to wall with wall brackets.
1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 2. Secure wall brackets to building construction as required to comply with performance requirements.

END OF SECTION 055119

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SECTION 055313 - BAR GRATINGS

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 metal bar gratings.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
 - 2. Section 055000 "Metal Fabrications" for grating supports.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of grating with installation of related items. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Clips and anchorage devices for gratings.
 - 2. Paint products.
 - 3. Manufacturers' published load tables.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work. Identify size, material, and location of supporting members and forward requirements to Section 055000 "Metal Fabrications".
- C. Samples for Verification:
 - 1. Submit 12-inch by 12 -inch samples of metal grating, illustrating surface finish, color, texture, and jointing details.

1.5 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by manufacturers of aluminum, steel, and stainless steel certifying that products furnished comply with requirements.
- B. Welding certificates, qualified in the previous 12 months.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide grating conforming to ANSI/NAAMM MBG 531, Type P-19-4, size of grating as shown on Drawings. Do not exceed fabricator's maximum recommended grating span.
- B. Limit grating deflection to 1/4 inch maximum for a uniform live load of 100 psf on maximum span.

2.2 METAL BAR GRATINGS

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
- B. Pressure-Locked, Rectangular-Bar Aluminum Grating ANSI/NAAMM MBG 531 Type P-19-4: Fabricate by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
 - 1. Traffic Surface: Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.
 - 2. Aluminum Finish: Class I, clear, anodized finish.
- C. Pressure-Locked, Aluminum I-Bar Grating: Fabricated by swaging crossbars between bearing bars.

1. Bearing Bar Spacing: 1-3/16 inches o.c.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Flange Width: 1/4 inch.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.
6. Aluminum Finish: Class I, clear, anodized finish.

2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A510.
- D. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30.
- E. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33, with G90 coating.

2.4 ALUMINUM

- A. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.
- B. Extruded Bars and Shapes: ASTM B221/B221M, alloys as follows:
 1. Grating Bearing Bars: 6061-T6 or 6063-T6.
 2. Grating Crossbars: 6061-T1.
- C. Aluminum Sheet: ASTM B209/B209M, Alloy 5052-H32.
- D. Welding Electrode, Aluminum: 5356 filler alloy.

2.5 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 1. Provide stainless steel fasteners for fastening aluminum.
 2. Provide stainless steel fasteners for fastening stainless steel.
- B. Grating clamps, nuts, bolts, washers, and other fastening devices for grating shall be Type 316 stainless steel. Anchor blocks, when used, shall be of the same material as the grating. Anchor grating to supporting system using saddle clips.

2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.7 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and 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.
- F. Provide for anchorage of type specified; coordinate with supporting structure.
 - 1. Fabricate toeplates to fit grating units and weld to units in shop, unless otherwise indicated.
 - 2. Toeplate Height: 4 inches, unless otherwise indicated.
- G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 - 1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
 - 2. Provide no fewer than four saddle clips for each grating section with each clip designed and fabricated to fit over two bearing bars.
 - 3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced less than 15/16 inch o.c., with each lug shop welded to two or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
 - 4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
 - 5. Furnish threaded bolts with nuts and washers for securing grating to supports.
 - 6. Furnish self-drilling fasteners with washers for securing grating to supports.

7. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.
- H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- I. Additional Fabrication:
 1. Edge-band openings in grating that interrupt one or more bearing bars with bars of same size and material as bearing bars.
 2. Do not notch bearing bars at supports to maintain elevation.
 3. For openings 2 inches or greater in diameter or dimension, band grating edges with a bar of same depth and thickness as bearing bars. Weld cut bearing bars or cross bars to banding bar.
 4. Provide trench grating with symmetrical cross bar arrangement.
 5. Fabricate metal frames and supports for grating of same material as grating, unless otherwise indicated.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I.
- B. Mill finish.

2.9 STEEL FINISHES

- A. Finish gratings.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate locations and elevations of grating supports provided under provisions of Section 055000 "Metal Fabrications." Verify that members are properly installed to support bar gratings specified in this Section.
- B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install assemblies in accordance with manufacturer's installations instructions. Install products plumb, level, and square, unless otherwise required by the design.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction and grating supports.
- C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- D. Provide additional supports at penetrations through grating in order to meet design criteria.
- E. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Attach toeplates to gratings by welding at locations indicated.
- G. Field Welding: Comply with AWS recommendations and 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.
- H. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners as specified.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0 -mil dry film thickness.

- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099679 “Atmospheric Protection and Plant Service Areas Coating”.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055313

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SECTION 067413 - FIBERGLASS REINFORCED PLASTIC COMPONENTS

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. FRP gratings, frames, and supports for gratings guardrails and plates.
 - 2. Delegated Design.

1.3 DEFINITIONS

- A. FRP: Refers to fiberglass reinforced plastic or glass fiber reinforced plastics.

1.4 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, guardrails, plates and supports.
- B. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete as specified in Division 03 or masonry as specified in Division 04. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

- A. Test Data: Certified data based on tests of actual production samples which demonstrate that products conform to specified stress and deflection requirements.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.6 DELEGATED DESIGN SUBMITTALS

- A. Delegated Design Submittal: For FRP components, including manufacturer's published load tables and analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer confirming registration in State where project site exists.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The manufacturers of fiberglass reinforced plastic components shall be experienced in the manufacture of the items specified. Present proof as required demonstrating successful installations of the specified items under conditions similar to those of this project.
- B. Coordinate the work of this Section with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Transport, lift, and handle units with care, avoiding excessive stress and preventing damage; use appropriate equipment.
- B. Store in a clean dry area off the ground and protected from weather, moisture, and damage; do not stack unless permitted by manufacturer.
- C. Handle products to prevent damage from abrasion, cracking, chipping, twisting, deformations, and other types of damage.

1.10 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design FRP components.
- B. Resin for FRP components: Vinyl ester, integrally resistant without applied coatings to: ultra-violet radiation; high concentrations of hydrogen sulfide gas, its solutions and associated compounds; and to the wastewater occurring at the project site.

1. Provide compatible and equally resistant resin as acceptable for shop and field sealing of cut edges.
- C. Colors: Integral colors acceptable to Engineer selected from standard resin colors.
- D. Pultruded fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
- E. Minimum physical properties for pultruded structural FRP shapes and plates:
 1. Tensile Strength: According to ASTM D638.
 - a. Coupon: 30,000 psi.
 - b. Full Section in Bending: 19,986 psi at 75 degrees F.
 2. Modulus of Elasticity: According to ASTM D790.
 - a. 32.3×10^6 psi at 75 degrees F.
 - b. 1.8×10^6 psi at 125 degrees F.
 3. Barcol Hardness: 50.
 4. Water Absorption: 0.75 percent (by weight), according to ASTM D349.
 5. Specific Gravity: 1.66, according to ASTM D792.
- F. Provide pultruded shapes conforming to the visual quality of ASTM D4385.
- G. Protect pultruded and molded FRP from ultraviolet (UV) degradation with:
 1. Integral UV inhibitors in the resin.
 2. A synthetic surfacing veil to produce a resin rich surface.
- H. Structural Performance: Withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 1. Floors: Uniform load of 250 lb/sq. ft. or concentrated load of 3000 lb, whichever produces the greater stress.
 2. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lb/sq. ft.
 3. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lb/sq. ft.
 4. Limit live load deflection to L/360 or 1/4 inch, whichever is less.
- I. Seismic Performance: Gratings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. Component Importance Factor: 1.5.

2.2 GRATING COMPONENTS

- A. Molded FRP Gratings: Bar gratings made by placing glass-fiber strands that have been saturated with thermosetting plastic resin in molds in alternating directions to form interlocking bars without voids and with a high resin content.

1. Configuration: As required to comply with structural performance requirements.
 2. Weight: 4.1 lb/sq. ft.
 3. Resin: Polyester or vinylester.
 - a. Flame-Spread Index: 25 or less when tested according to ASTM E84.
 - b. USDA Acceptance: Accepted for food-processing applications.
 4. Color: Manufacturer's standard.
 5. Traffic Surface: Applied abrasive finish.
- B. Pultruded FRP Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.
1. Configuration: As required to comply with structural performance requirements.
 2. Weight: 4.10 lb/sq. ft.
 3. Resin Type: Polyester or vinylester.
 - a. Flame-Spread Index: 25 or less when tested according to ASTM E84.
 - b. USDA Acceptance: Accepted for food-processing applications.
 4. Color: Manufacturer's standard.
 5. Traffic Surface: Applied abrasive finish.
- C. Protect grating from ultraviolet (UV) degradation with:
1. Integral UV inhibitors in the resin.
 2. A synthetic surfacing veil to produce a resin rich surface.
- D. Securely attach FRP grating to supporting members and angles using either stainless steel or FRP with stainless steel fasteners. Attach each grating panel to supporting members at a minimum of four locations, two at each edge. Provide materials and incidentals required for attaching grating to angle frame and supports under this Section.
- E. Coordinate grating panel layouts with work of other Sections to provide openings for approved mechanical equipment, operators, gates, and other items which require penetrations or openings in the grating. Further subdivide grating panels and support to provide maximum panel weight of 110 lbs.

2.3 MISCELLANEOUS COMPONENTS

- A. Provide structural FRP angle frames, structural support shapes, and grit impregnated plate where required and appurtenances as indicated.
- B. Provide angle frames continuous around the opening in order to present an even and flat support for the grating except as otherwise indicated.
- C. Provide all finished surfaces of FRP items and fabrications smooth, resin rich, free of voids and without dry spots, cracks, crazes, or unreinforced areas. Provide glass fibers well covered with resin to protect against exposure due to wear or weathering.

- D. Provide all exposed surfaces smooth and true to form, consistent with ASTM D4385.

2.4 GUARDRAIL SYSTEM

- A. Design FRP guardrail system, including connections, to meet loading and deflection requirements of OSHA and ICC AC 273.
 - 1. Basis-of-Design: Safrail Handrail System by Strongwell Corporation; Dynarail Guardrail and Handrail by Fibergrate; or equal.
- B. Provide system composed of 2-inch square FRP tubes; solid FRP connector plugs snugly fitting inside dimensions of tubes; solid 0.49-inch diameter FRP connector rods; and flattened corrugated 0.125-inch thick, 4-inch high, FRP kickplates with 0.5-inch deep corrugations and stainless-steel drive rivets for fastening to posts.
- C. Provide FRP sleeves for removable connections to concrete and FRP baseplate assemblies with stainless-steel fasteners for wall connections and for slab connections where shown. Provide approved epoxy cement for tube, plug and rod connections and epoxy grout for post connections set in concrete.
- D. Fabricate with continuous posts and top rail, and intermediate rails cut between posts. Miter corners and direction changes. Provide for rail expansion with internal plugs cemented one side and square, resin sealed, tube ends. Provide for kickplate expansion as detailed.

2.5 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 1.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
- E. Post-Installed Anchors: Refer to Section 050519 "Post Installed Anchors and Reinforcing Bars."

2.6 FABRICATION

- A. Shop Assembly: Shop fabricate grating sections to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form FRP components from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
- F. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

2.7 FRP FRAMES AND SUPPORTS

- A. Frames and Supports for FRP Gratings and Plates: Fabricate from FRP shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1. Unless otherwise indicated, use shapes made from same resin as gratings.
 - 2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate locations and elevations of required supports. Verify that members are properly installed to support components specified in this Section.
- B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install assemblies in accordance with manufacturer's installations instructions. Install products plumb, level, and square, unless otherwise required by the design.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

- C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing FRP components. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry. Provide additional supports at penetrations through grating in order to meet design criteria.
- E. Fit exposed connections accurately together to form hairline joints.

3.3 INSTALLING FRP COMPONENTS

- A. Comply with manufacturer's written instructions for installing components. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for grating anchorage.

END OF SECTION 067413

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SECTION 079200 - JOINT SEALANTS

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. Nonstaining silicone joint sealants.
2. Urethane joint sealants.
3. Immersible joint sealants.
4. Butyl joint sealants.
5. Latex joint sealants.

- B. Related Requirements:

1. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- 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. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 FIELD 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 degrees F.
 - 2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, 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 joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation.
 - b. Sika Corporation Joint Sealants.
 - c. The Dow Chemical Company.

2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bostik; Arkema.
 - b. Pecora Corporation.
 - c. Tremco Incorporated.
- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation.
 - b. Polymeric Systems, Inc.
 - c. Sherwin-Williams Company (The).
- C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.
 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. LymTal International, Inc.

2.4 IMMERSIBLE JOINT SEALANTS

- A. Immersible Joint Sealants. Suitable for immersion in liquids; ASTM C1247, Class 1; tested in deionized water unless otherwise indicated
- B. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sika Corporation Joint Sealants.
 - b. Tremco Incorporated.
 - c. W. R. Meadows, Inc.

2.5 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bostik; Arkema.
 - b. Everkem Diversified Products, Inc.
 - c. Pecora Corporation.

2.6 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation.
 - b. Sherwin-Williams Company (The).
 - c. Tremco Incorporated.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alcot Plastics Ltd.
 - b. Construction Foam Products; a division of Nomaco, Inc.
 - c. Master Builders Solutions.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 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: Nonstaining, 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 performance of the Work.
- 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, 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.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate 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.

- B. **Joint Priming:** Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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 or primer 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 C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **Install sealant backings of kind 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 bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.**
- E. **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.
- F. **Tooling of Nonsag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs 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 profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 2 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 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.

3.6 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 - 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
 - 1. Joint Locations:
 - a. Joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, immersible, S, P, 25, T, NT, I.
 - 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between metal panels.
 - c. Joints between different materials listed above.
 - d. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - e. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 - 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, P, 25, T, NT.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- G. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Door thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL 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:
 - 1. Exterior standard steel doors and frames.
 - 2. Glazing for half lite doors.
- B. Related Requirements including, but not limited to:
 - 1. Section 079200 "Joint Sealants" for sealants around door frames.
 - 2. Section 087100 "Door Hardware" for door hardware of hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware.
- C. Coordinate and field verify installation of doors and frames with existing door openings at Control and Blower Building. Verify openings by field measurements before fabrication and indicate measurements on shop drawings.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 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, including existing door openings at Control and Blower Building.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
- C. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.
- D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Record Documents: List of door numbers and applicable room name and number to which door accesses.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to 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 doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ceco Door; AADG, Inc.; ASSA ABLOY Group.
 2. Curries, AADG, Inc.; ASSA ABLOY Group.
 3. Steelcraft; Allegion plc.

2.2 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.61 deg Btu/F x h x sq. ft. when tested according to ASTM C518.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard complying with performance requirement.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
 - b. Construction: Full profile welded.
 3. Exposed Finish: Factory.

2.4 BORROWED LITES GLAZING

- A. Clear laminated glass with two plies of heat-strengthened float glass (DA-102, DA-103).
1. Basis-of-Design Product: Vitro Architectural Glass; Starphire Solar Control Laminated Glass.
 2. Conformance: ASTM C1172 and complying with testing requirements.
 3. Outboard Lite: Starphire float glass as manufactured by Vitro Architectural Glass.
 - a. Conformance: ASTM C 1036, Type I, Class 1, Quality q3.
 - b. Thickness: 1/4-inch.
 - c. Heat-Treatment: Heat-strengthened, ASTM C 1048, Kind HS.
 4. Interlayer:
 - a. Type: PVB.
 - b. Thickness: 0.060-inch.
 - c. Color: Clear.
 5. Inboard Lite: Solargray Clear float glass as manufactured by Vitro Architectural Glass.
 - a. Conformance: ASTM C 1036, Type I, Class 2, Quality q3.
 - b. Thickness: 1/4-inch.
 - c. Heat-Treatment: Heat-strengthened, ASTM C 1048, Kind HS.
 - d. Magnetic Sputter Vacuum Deposition Coating (MSVD): ASTM C1376.
 - e. Coating: Solarban 70 on Surface # 3.
 6. Overall Thickness: 9/16-inch.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

2.7 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.

4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation 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.

2.8 STEEL FINISHES

- A. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
 1. Color and Gloss:
 - a. Control and Blower Building Doors and Frames: Dark green color and semi-gloss.
 - b. Belt Filter Press Building Doors and Frames: White color and semi-gloss.

PART 3 - EXECUTION

3.1 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. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: 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 without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 2. Floor Anchors: Secure with postinstalled expansion anchors.
 3. Solidly pack mineral-fiber insulation inside frames.
 4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

- b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
- 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
- D. Glazing: Comply with installation requirements per hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Engineer.
- B. Inspections:
- 1. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 REPAIR

- A. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

END OF SECTION 081113

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SECTION 085113 - ALUMINUM WINDOWS

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 aluminum windows for exterior locations.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
 - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
 - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
 - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.
 - 1. Include plans, elevations, sections, accessories, and details of installation, including anchor, flashing, and sealant installation.
- C. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
- C. Sample Warranties: For manufacturer's warranties.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.
 - 2. Warranty Period:
 - a. Window: 10 years from date of Substantial Completion.
 - b. Glazing Units: 10 years from date of Substantial Completion.
 - c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: R.
 - 2. Minimum Performance Grade: 15.
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.35 Btu/sq. ft. x h x degree F.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.30.
- E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 or less.
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 degrees F ambient; 180 degrees F material surfaces.
- G. Sound Transmission Class (STC): Rated for not less than 30 STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.

2.3 ALUMINUM WINDOWS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. EFCO Corporation.
 - 2. Kawneer Company, Inc.; Arconic Corporation.
 - 3. YKK AP America Inc.
- B. Types: Provide the following types in locations indicated on Drawings:
 - 1. Fixed.
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials

and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

D. Insulating-Glass Units: Double Glazed Clear Insulating Glass Unit, Low-E.

1. Basis-of-Design Product: Vitro Architectural Glass; Solarcoat Low-e on Clear 1/4-inch (#2) | Air 1/2-inch | Solarcoat Low-e on Clear 1/4-inch (#3).
2. Conformance: ASTM E2190.
3. Outdoor Lite: Clear float glass as manufactured by Vitro Architectural Glass.
 - a. Conformance: ASTM C1036, Type 1, Class 1, Quality q3.
 - b. Glass Thickness: 1/4-inch.
 - c. Pyrolytic deposition coating: ASTM C1376.
 - d. Coating: Solarcoat Low-E on Surface # 2.
 - e. Heat-Treatment: Tempered; ASTM C1048, Kind FT; Safety Glazing meets ANSI Z97.1 and CPSC 16CFR-1201.
4. Interspace Content: Air 1/2-inch.
5. Indoor Lite: Clear float glass as manufactured by Vitro Architectural Glass.
 - a. Conformance: ASTM C1036, Type 1, Class 1, Quality q3.
 - b. Glass Thickness: 1/4-inch.
 - c. Pyrolytic deposition coating: ASTM C1376.
 - d. Coating: Solarcoat Low-E on Surface # 3.
 - e. Heat-Treatment: Tempered; ASTM C1048, Kind FT; Safety Glazing meets ANSI Z97.1 and CPSC 16CFR-1201.

E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide

for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

- F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual" 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.

2.6 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
 - 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
 - 2. Air-Infiltration Testing:
 - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
 - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
 - 3. Water-Resistance Testing:
 - a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
 - 4. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
 - 1. Keep protective films and coverings in place until final cleaning.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113

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SECTION 087100 - DOOR HARDWARE

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. Mechanical door hardware for the following:

- a. Swinging doors.

- B. Related Requirements:

- 1. Section 081113 "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.

1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner's security consultant.

- B. Keying Conference: Conduct conference at Project site.

1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner's security consultant.
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - a. Flow of traffic and degree of security required.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each exposed product in each finish specified, in manufacturer's standard size.
 1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- C. Samples for Initial Selection: For each type of exposed finish.
- D. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
 3. Content: Include the following information:
 - a. Identification number, location, hand, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Fastenings and other installation information.
 - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - f. Mounting locations for door hardware.
 - g. List of related door devices specified in other Sections for each door and frame.
- E. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying

diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Engineer, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
- a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2010 ADA Standards for Accessible Design" and 2012 Texas Accessibility Standards.
 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 2. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
 3. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.2 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Hager Companies.
 - c. McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY.

2.3 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Backset: 2-3/4 inches unless otherwise indicated.

- C. Lock Trim:
 - 1. Description: As indicated on door hardware schedule.
 - 2. Levers: Cast.
 - 3. Escutcheons (Roses): Cast.
 - 4. Dummy Trim: Match lever lock trim and escutcheons.
- D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
- E. Mortise Locks: BHMA A156.13; Operational Grade 1 and Security Grade 1; stamped steel case with steel or brass parts; Series 1000.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
 - c. SARGENT Manufacturing Company; ASSA ABLOY.

2.4 AUXILIARY LOCKS

- A. Mortise Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. SARGENT Manufacturing Company; ASSA ABLOY.
 - c. STANLEY; dormakaba USA, Inc.

2.5 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
 - c. SARGENT Manufacturing Company; ASSA ABLOY.

2.6 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Interchangeable.
- C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 2 construction master keys.
- D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 2 construction master keys.

2.7 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.
 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."

2.8 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY.
 - c. Trimco.

2.9 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Allegion plc.
- b. Norton Door Controls; ASSA ABLOY.
- c. SARGENT Manufacturing Company; ASSA ABLOY.

2.10 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Rixson Specialty Door Controls; ASSA ABLOY.
 - c. SARGENT Manufacturing Company; ASSA ABLOY.

2.11 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. National Guard Products, Inc.
 - c. Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY.

B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:

1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.

2.12 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. National Guard Products, Inc.
 - b. Pemko Manufacturing Company Inc.; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY.
 - c. Rixson Specialty Door Controls; ASSA ABLOY.

2.13 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Rockwood Manufacturing Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY.
 - c. Trimco.

2.14 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location.
 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 1. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 2. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.15 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other 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 doors and frames, with Installer present, for compliance with requirements for installation tolerances, wall and floor construction, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's 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. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
- E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter gasketing to install other surface-applied hardware.

- G. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

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.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

3.8 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

Hardware Sets

Set: 1.0

Doors: DE-100A, DE-100B, DK-102A, DK-103A

Description: EXTERIOR SINGLE HM UTILITY

1 Continuous Hinge	CFM x Height Required x SLI-HD1	PE	087100
1 Storeroom Lock	10 8204 LNL	US32D SA	087100
1 Surface Closer	281 CPS	EN SA	087100
1 Kick Plate	K1050 10" x 2" LDW (Single) 1" LDW (Pair) BEV CSK	US32D RO	087100
1 Threshold	2005AT	PE	087100
1 Rain Guard	346C + 4" Overall Door Width	PE	087100
1 Gasketing	2891AV	PE	087100
1 Sweep	345CNB	PE	087100

Set: 2.0

Doors: DK-101A

Description: EXTERIOR PAIR HM A/I PANIC

Continuous Hinge	CFM x Height Required x SLI- HD1	PE	087100
Flush Bolt	555	US26D RO	087100
Dust Proof Strike	570	US26D RO	087100
Mortise Exit Device, Storeroom	10 8904 ETL	US32D SA	087100
Surface Closer	281 CPS	EN SA	087100
Kick Plate	K1050 10" x 2" LDW (Single) 1" LDW (Pair) BEV CSK	US32D RO	087100
Threshold	2005AT	PE	087100
Rain Guard	346C + 4" Overall Door Width	PE	087100
Gasketing	2891AV	PE	087100
Sweep	345CNB	PE	087100
Astragal	18041CNB	PE	087100

Set: 3.0

Doors: DE-100C

Description: OVERHEAD DOOR

1 Balance of Hardware	By Assembly Mfr	OT
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END OF SECTION 087100

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SECTION 099676.23 – WASTEWATER PRELIMINARY TREATMENT COATINGS

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 surface preparation and application of high-performance coating systems on the following substrate:
 - 1. Ductile iron pipes at Influent Lift Station and Wet Well.
- B. Related Requirements:
 - 1. Section 099679 “Atmospheric Protection and Plant Service Coatings” for non-submerged ductile iron pipes coating protection.
 - 2. Section 400519 “Ductile Iron Process Pipe” for ductile pipe.
 - 3. Section 400551 “Common Requirements for Process Valves” for factory finish valves.

1.3 DEFINITIONS

- A. MPI Gloss Levels: Following define gloss levels according to ASTM D523:
 - 1. MPI Gloss Level 6 - Traditional Gloss: 70 to 85 units at 60 degrees.
- B. Moderate Exposure: An atmosphere that can be characterized as corrosive, within reasonable limits, is considered a moderate environment. In an industrial setting, a moderate environment indicates intermittent exposure to high humidity and condensation with occasional development of mold and mildew. Exposure to heavy concentrations of chemical fumes or mist and accidental chemical spills or splash occurs occasionally in a moderate environment. Regular use of strong chemicals rather than standard commercial cleaning agent also changes a mild environment into a moderate one. Metal corrosion is common in a moderate environment.
- C. Severe Exposure: An aggressively corrosive industrial or predominantly chemical environment with regular exposure to strong chemical fumes, mists, and dust is considered a severe environment. In an industrial setting, a severe environment is one with sustained exposure to high humidity and condensation that results in heavy development of mold and mildew. Frequent spilling and splashing of strong chemicals (acids, alkalis, oxidizers, and solvents) are also characteristic of a severe environment. Metal corrosion can be expected in a severe environment. Immersion conditions, marine environment with sustained exposure to saltwater spray, and arctic environment with long periods of extremely low temperature are considered severe environments. These are areas where if no high-performance coatings are applied on steel or concrete, very early failure and structural damage will be evident.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on actual substrate material to be coated, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: Use same designations indicated on Drawings and in Preliminary Treatment Coating Schedule. Include color designations and product runs (batch numbers).

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run, (batch number) that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Coatings: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Engineer will select one surface to represent surfaces and conditions for application of each coating system. Engineer will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Engineer at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Deliver materials on site in factory sealed containers from the manufacturer. Do not use materials from previous jobs.

1.8 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are within the coatings manufacturer's recommendations.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point and rising; or to damp or wet surfaces.
- C. Lead Paint: It is not expected that lead paint will be encountered in the Work.
 1. If suspected lead paint is encountered, do not disturb; immediately notify Engineer and Owner.
- D. Do not apply exterior coatings in snow, rain, fog, mist, and in conditions that do not meet the manufacturer's recommendations.

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. Carboline Company (CAR).
 2. PPG Paints (PPG).
 3. The Sherwin-Williams Company (SWC).
 4. Tnemec Company, Inc. (TNE).

2.2 HIGH-PERFORMANCE COATINGS

- A. Material Compatibility:
 1. Each coating system within indicated substrates uses compatible material with one another, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. Topcoat manufacturer recommends products in writing for use in each coating system coat and on indicated substrate.
 3. Use products from same manufacturer for each coat in coating system.
- B. Colors: As indicated in color schedule.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
1. Application of coating indicates acceptance of surfaces and conditions.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be coated.
1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 2. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed.
 3. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by manufacturer.
1. NAPF 500-03, "Surface Preparation Standard for Ductile Iron Pipe and Cast Ductile Iron Fittings."

3.3 APPLICATION

- A. Apply high-performance coatings in accordance with manufacturer's written instructions.
1. Use applicators and techniques suited for coating and substrate indicated.
 2. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.
- D. Film Thickness: Apply paint in wet film thickness (WFT) recommended by high-performance manufacturer to achieve specified dry film thickness (DFT) for each coat of paint. Since DFT varies among manufacturers, this reference is not included in Article "Preliminary Treatment Coating Schedule."

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
1. Contractor shall touch up and restore coated surfaces damaged by testing.
 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

- A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.

- C. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 PRELIMINARY TREATMENT COATING SCHEDULE

- A. Ductile or Cast-Iron Substrates: Submerged Pipes in Wastewater..

- 1. Moderate to Severe Exposure:

- a. 100 percent Solids Reinforced Epoxy System:

- 1) Direct to Metal Coat: (MPI Gloss Level 6).

- a) CAR: Plastile 4500 Series.
- b) PPG: Raven 405.
- c) SWC: Duraplate 6000.
- d) TNE: Series 436.

END OF SECTION 099676.23

SECTION 099679 – ATMOSPHERIC PROTECTION AND PLANT SERVICE AREAS COATINGS

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 surface preparation and application of high-performance coating systems for water and wastewater treatment on the following substrates:
 - 1. Exterior Non-submerged Substrates:
 - a. Steel pipe supports.
 - b. Steel Grit Chamber platform and supports.
 - c. Ductile iron pipes at Grit System and Influent Lift Station above grade.
 - d. Ductile iron 20” – ABI and 18” – ABI at the aeration basin.
- B. Related Requirements:
 - 1. Section 099676.23 “Wastewater Preliminary Treatment Coatings” for submerged ductile iron pipes coating protection.
 - 2. Section 400519 “Ductile Iron Process Pipe” for ductile pipe.
 - 3. Section 400551 “Common Requirements for Process Valves” for factory finish valves.

1.3 DEFINITIONS

- A. MPI Gloss Levels: Following define gloss levels according to ASTM D523:
 - 1. MPI Gloss Level 6 - Traditional Gloss: 70 to 85 units at 60 degrees.
- B. Mild Exposure: Normal outdoor weathering and standard industrial exposures are considered mild environments. A normal industrial setting is one with low to moderate levels of humidity and condensation and little development of mold and mildew. A mild environment has only limited exposure to chemical fumes or mist, and occasional occurrences of chemical spills or splash. Regular cleaning with standard commercial chemical cleaning agents, with only occasional use of stronger chemical cleaning agents, is also characteristics of a mild environment. Metal corrosion will occur in a mild environment, but it is minimal. These are generally dry areas with little to no Hydrogen Sulfide (H₂S), Chlorine, or other corrosive chemicals, or the area is damp.
- C. Moderate Exposure: An atmosphere that can be characterized as corrosive, within reasonable limits, is considered a moderate environment. In an industrial setting, a moderate environment indicates intermittent exposure to high humidity and condensation with occasional development

of mold and mildew. Exposure to heavy concentrations of chemical fumes or mist and accidental chemical spills or splash occurs occasionally in a moderate environment. Regular use of strong chemicals rather than standard commercial cleaning agent also changes a mild environment into a moderate one. Metal corrosion is common in a moderate environment.

- D. Severe Exposure: An aggressively corrosive industrial or predominantly chemical environment with regular exposure to strong chemical fumes, mists, and dust is considered a severe environment. In an industrial setting, a severe environment is one with sustained exposure to high humidity and condensation that results in heavy development of mold and mildew. Frequent spilling and splashing of strong chemicals (acids, alkalis, oxidizers, and solvents) are also characteristic of a severe environment. Metal corrosion can be expected in a severe environment. Immersion conditions, marine environment with sustained exposure to saltwater spray, and arctic environment with long periods of extremely low temperature are considered severe environments. These are areas where if no high-performance coatings are applied on steel or concrete, very early failure and structural damage will be evident.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on actual substrate material to be coated, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: Use same designations indicated on Drawings and in Atmospheric Protection Coating Schedule and Plant Service Areas Coating Schedule. Include color designations and product runs (batch numbers).

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run (batch number), that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Coatings: 5 percent, but not less than 1 gallon of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Engineer will select one surface to represent surfaces and conditions for application of each coating system.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Engineer will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Engineer at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
 - 4. 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. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.
 - 3. Deliver materials on site in factory sealed containers from the manufacturer. Do not use materials from previous jobs.

1.8 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are within the coatings manufacturer's recommendations.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point and rising; or to damp or wet surfaces.
- C. Lead Paint: It is not expected that lead paint will be encountered in the Work.
 - 1. If suspected lead paint is encountered, do not disturb; immediately notify Engineer and Owner.
- D. Do not apply exterior coatings in snow, rain, fog, mist, and in conditions that do not meet the manufacturer's recommendations.

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. Carboline Company (CAR).
 2. PPG Paints (PPG).
 3. The Sherwin-Williams Company (SWC).
 4. Tnemec Company, Inc. (TNE).

2.2 HIGH-PERFORMANCE COATINGS

- A. Material Compatibility:
1. Each coating system within indicated substrates uses compatible material with one another, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. Topcoat manufacturer recommends products in writing for use in each coating system coat and on indicated substrate.
 3. Use products from same manufacturer for each coat in coating system.
- B. Colors: As selected by Engineer from manufacturer's full range.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
 - 1. Application of coating indicates acceptance of surfaces and conditions.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be coated.
 - 1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 2. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed.
 - 3. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by manufacturer but not less than the following:
 - 1. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 - 2. SSPC-SP 10/NACE No. 2, "Near White Blast Cleaning."
 - 3. SSPC-SP 6/NACE No. 3, "Power Tool Cleaning."
 - 4. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 - 5. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
 - 6. NAPF 500-03, "Surface Preparation Standard for Ductile Iron Pipe and Cast Ductile Iron Fittings."
 - 7. SSPC-SP 16, "Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

3.3 APPLICATION

- A. Apply high-performance coatings in accordance with manufacturer's written instructions.
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

- B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.
- D. Film Thickness: Apply paint in wet film thickness (WFT) recommended by high-performance manufacturer to achieve specified dry film thickness (DFT) for each coat of paint. Since DFT varies among manufacturers, this reference is not included in Article “Atmospheric Protection Coating Schedule and Plant Service Areas Coating Schedule.”

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

- A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 ATMOSPHERIC PROTECTION COATING SCHEDULE

- A. Exterior Weathering and Protection: Non-submerged and atmospheric service.
 - 1. Steel Substrates: Moderate to Severe Exposure.
 - a. Pigmented Polyurethane over Zinc-Rich Primer and Epoxy Intermediate System:
 - 1) Prime Coat:
 - a) CAR: Carbozinc 859.
 - b) PPG: Amercoat 68HS.
 - c) SWC: Corothane I Galvapak.
 - d) TNE: Series 94-H2O.

- 2) Intermediate Coat:
 - a) CAR: Carboguard 60/Carboguard 635VOC.
 - b) PPG: Amerlock 2/400.
 - c) SWC: Macropoxy 646 PW.
 - d) TNE: Series 66.
 - 3) Topcoat: (MPI Gloss Level 6).
 - a) CAR: Carbothane 134UV.
 - b) PPG: Pitthane Ultra.
 - c) SWC: Acrolon 218.
 - d) TNE: Series 1094.
2. Ductile Iron or Cast-Iron Substrates: Moderate to Severe Exposure.
- a. Polyurethane over Epoxy System:
 - 1) Prime Coat:
 - a) CAR: Carboguard 60/Carboguard 635VOC.
 - b) PPG: Amerclock 2/400.
 - c) SWC: Macropoxy 646 FC Epoxy.
 - d) TNE: Series 66.
 - 2) Topcoat: (MPI Gloss Level 6).
 - a) CAR: Carbothane 134 series.
 - b) PPG: Pitthane Ultra.
 - c) SWC: Acrolon 218.
 - d) TNE: Series 1074.

END OF SECTION 099679

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SECTION 133313 - GEODESIC DOMES

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. Design, fabrication, and delivery to the project site and to erect, complete, Aluminum Dome Cover Systems. One 94-foot inside diameter Aluminum Dome Cover System shall be provided including structural support bearings and attachment hardware to existing steel walls. The Dome Cover System shall completely enclose the surface of the existing Clearwell.
 - 2. Delegated Design.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications."
 - 2. Division 23 "Heating, Ventilating, and Air Conditioning."
 - 3. Section 460200 " Tank and Structure cleaning"

1.3 ACTION SUBMITTALS

- A. Product Data: Submit product information including a sample of the panels, specifications, and installation instructions for all components and accessories. The information shall indicate sizes, thicknesses, and materials of construction.
- B. Shop Drawings:
 - 1. Submit the following:
 - a. Prior to the first submittal of the plans and layouts, field measurements of the existing tank and the method used to collect these measurements shall be submitted for review.
 - b. Shop drawings showing dimensions and details of attachment and support of the cover systems on the steel tank walls. Indicate vertical and horizontal forces for applicable loads and combinations of loads in kips at all bearings.
 - c. shop and erection drawings for the primary and secondary framing and panels. Shop drawings shall include plans and layouts, connection and framing details, fastener types and spacing, and product description information.

- d. Letter signed and sealed by the structural engineer of record for the work of this Section certifying that the structural framing and covering panels proposed meet the structural design criteria specified herein.
 - e. One set of reproducible “as-built” erection plans stamped by the structural engineer of record for the work of this Section.
2. Provide all final approved shop drawings, installation instructions, certified test reports, electrical and other schematics, drawings, data sheets, operations and maintenance manuals, and warranties and guaranties in hard copy and digital format. Materials available in digital/electronic format shall be furnished.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 DELEGATED DESIGN SUBMITTALS

- A. For geodesic dome system including the following:
1. Certification of the satisfactory inspection of all welds of aluminum structural components shall be submitted prior to the delivery of the fabricated materials.
 2. All drawings and calculations shall be signed and stamped by a licensed professional engineer registered in the State of Texas experienced and knowledgeable in the design of aluminum dome covers.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: None.
- B. Upon the completion of construction of the Aluminum Dome Cover Systems, furnish one copy of the design calculations of the “as-built” domes stamped by the structural engineer of record for the work of this Section. Calculations shall be submitted for record purposes only and will not be reviewed by the Engineer.
- C. Plan for quality control of all fabrications, including final inspection.
- D. Descriptive literature, bulletins and/or catalogs of the equipment, including photographs from each of the last five projects and photographs from at least five similar projects.
- E. The weight of the covers, including the weight of the single largest component.
- F. A complete total bill of materials, including supplier, supplier's parts ordering information.
- G. A list of the manufacturer's recommended spare parts. Include gaskets, seals, sealants, repair kits, recommended cleaning agents, on the list.
- H. Methods for installation and removing the covers, including specific tools and equipment required and sequence of removal.
- I. Specific information on all materials used and methods used in fabrication.
- J. Seismic Qualification Certificates: For dome, accessories, and components, from manufacturer.

- K. Welding certificates.
- L. Material certificates.
- M. Material test reports.
- N. Product test reports.
- O. Research reports.
- P. Source quality-control reports.
- Q. Field quality-control reports.
- R. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Two copies of an Operations and Maintenance Manual defining procedures for planned maintenance and repair, safety precautions as necessary, and assembly/disassembly procedures for removable items shall be provided at the time of owner's acceptance of the installed cover system.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code – Aluminum."
- D. Aluminum dome cover shall comply with AWWA D108 – Aluminum Dome Roofs for Water Storage Facilities.
- E. All equipment specified herein shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the products and the specific types of systems specified herein.
- F. The aluminum cover system manufacturer shall have complete in-house design and fabrication facilities. The manufacturer shall be solely responsible for the design, fabrication, delivery, erection, and satisfactory performance of the cover system specified herein, including all accessories and appurtenances that comprise the entire system. No division of responsibility between manufacturers of components is implied or allowed.
- G. The aluminum cover system manufacturer shall have quality control procedures adequate to ensure that all fabrications comply with these specifications and the MSBC and ensure that all

required material thicknesses are actually installed. Quality control shall include a final inspection by the manufacturer and a written record of this final inspection.

- H. Cover system suppliers shall provide a list of the last five cover installations at wastewater treatment facilities regardless of the size, shape or perceived successes of these installations. Included with the lists shall be contact names for the owner and contractor and a minimum of four pictures from each installation. Pictures shall include support details, equipment penetration details, and overall, complete system pictures.
- I. The design shall be prepared by a licensed professional engineer, registered in the State of Texas, experienced and knowledgeable in the design of aluminum dome covers.
- J. Installation shall be executed by a qualified and experienced erection crew. Cover manufacturer shall furnish all factory labor and supervision; furnish all materials and installation equipment; and furnish all incidentals required. Cover manufacturer, or the manufacturer's designated erector, shall install and completely make ready the Aluminum Dome Covering Systems suitable for use in treated wastewater effluent applications. The manufacturer's representative must be present for all cover installations.
- K. Tank cover systems shall be new and not previously used.
- L. Provide on-site services of a qualified manufacturer's representative to ensure that cover systems are installed in strict compliance with manufacturer's requirements. The manufacturer's representative shall also certify that the entire installation is in accordance with the manufacturer's recommendations.

1.8 DELIVERY

- A. At the time of delivery, all material should be inspected for shipping and handling damage. Replace or repair all damaged material to the satisfaction of the Engineer, at no additional cost to the Owner.
- B. Protect the surface of aluminum units from cuts, scratches, gouges, abrasions, and impacts. Do not use wire slings unless material is fully protected. Use spreader bars when lifting these materials. Do not drag panels or flashing across one another unless separated by a non-scratching spacer.
- C. Store all aluminum panels on edges; do not store flat. Keep all aluminum materials covered. Do not stack or store other building materials on top of unprotected units. Store materials in a dry location, up off the ground, and allow for ventilation.
- D. Damaged Material:
 - 1. Replace or repair all damaged material to the satisfaction of the Engineer, at no additional cost to the Owner.
 - 2. Follow manufacturer's instructions for the proper materials and procedures for the repair of aluminum products.

1.9 WARRANTY

- A. All equipment supplied under this section shall be warranted by the manufacturer and Contractor for 1 year, per CIP 16 details.
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it will be replaced at no expense to the Owner.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exceptions to this provision shall be allowed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. CST Covers – Conroe, Texas (936) 539-1747.
 - 2. United Industries Group, Inc. – Lake Forest, California (949) 759-3200.
 - 3. Tank Connection • 3609 North 16th Street, Parsons, KS 67357 • 620-423-3010 or approved equal.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum dome structures and the support brackets to be field mounted to the existing steel tank wall.
- B. Seismic Performance: Dome 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 when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
 - 2. Component Importance Factor is 1.5.
 - 3. .
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: The cover system shall be capable of withstanding temperature stresses ranging from minus 10 to plus 160 degrees F.
- D. 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: 25 or less.

2. Smoke-Developed Index: 450 or less.
- E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Combustion Characteristics: ASTM E136.

2.3 MATERIALS

A. Aluminum Dome Covers:

1. The dome roof shall be clear span and self-supporting from the periphery structure. The frame shall consist of aluminum members with the joints arrayed on the surface of a sphere. The arrangement of members shall result in a pattern of triangular spaces to form a space truss. These spaces shall be closed with non-corrugated light gauge aluminum panels. The members shall be joined by means of bolting their flanges to aluminum gusset plates. The dome roof shall incorporate a tension ring near the base that shall support all outward thrust loads.
2. All metal components shall be aluminum or Type 300 series stainless steel. No galvanized, painted or plated steel shall be used anywhere in the dome. Dissimilar materials in the supporting structure shall be isolated from the aluminum dome by means of a compatible elastomeric gasket.
3. The entire structure shall be designed as a substantially airtight, watertight system under all load conditions. The design shall prevent water pooling at the joints through the use of a flanged hub cover.
4. The aluminum closure panels shall be attached continuously along their edges to the structural members by means of clamping bars, which engage the panels in an interlocking joint. This clamping bar shall also secure a continuous elastomeric weatherseal gasket, which shall form a continuous airtight, watertight seal along the panel edges that will not slip or disengage under all load conditions.
5. Materials of construction shall be as follows:
 - a. Aluminum structural shapes shall be alloy 6061-T6.
 - b. Plate material shall be aluminum alloy 6061-T6. Tension ring gussets shall have a minimum thickness of 0.375-inch.
 - c. Sheet material shall be aluminum alloy 3003-H16.
 - d. Bolts and fasteners shall be 6061-T6 aluminum, 7075-T73 aluminum, or series 300 stainless steel. Anchor bolts shall be series 300 stainless steel.
 - e. Other appurtenances as previously specified shall be of materials compatible with cover structure.
 - f. Support Bearings: Acceptable bearing surfaces for sliding bearings are Teflon to stainless steel only. To avoid damage to the Teflon and reduce the coefficient of bearing friction, do not bear Teflon on aluminum surfaces.
 - g. Sealant conforming to Federal Specification TT-S-00230C; resistant to ozone and ultraviolet light
 - h. Closure Gaskets: Conforming to Federal Specification ZZ-R-765, Class 2 Grade 50 or ASTM C509, resistant to ozone and ultraviolet light.
 - i. Tension Ring: Tension ring structural shapes shall be 6061-T6 aluminum. Design of the tension ring shall be based on the net cross section of the members and shall

not include top flange protrusions used for panel attachment, bolt holes, or outstanding legs which are not connected through the joints.

6. Dissimilar materials shall be separated from each other through the use of approved gaskets or coatings.
7. The cover systems shall be designed for outdoor installation.
8. The Contractor shall be fully responsible for ensuring that each cover system is supported solely by the tank's peripheral wall, and that the cover in no way interferes with mechanical equipment operating in or around each tank.
9. Primary and secondary members and panels shall be designed for all applicable loads and combinations of these loads as required by the MSBC and ASCE/SEI 7. At a minimum, basic design loads shall be as follows:
 - Panel Load 250 lbs acting on one square foot at any location or 60 lbs/ sq ft acting on the entire area of a panel, whichever is greater and non-concurrently with other loads
 - Live load 30 lbs/sq ft
 - Wind load Risk Category 3, Exposure C
 - Maximum vacuum inside cover 2-inches of water below atmosphere pressure
 - Unbalanced loading 30 lbs/sq ft
10. Design for loads and concentrated loads for piping, ductwork, and equipment attached to the structure and for the dead load of the cover itself.
11. The cover systems shall be capable of withstanding temperature stresses ranging from minus 10 to plus 160 degrees F.
12. The manufacturer shall be fully responsible for the design and structural integrity of the covers and their anchorage to the structure, consisting of the tank's peripheral wall. The cover supports shall be spaced as recommended by the cover manufacturer and based on the conditions specified herein.
13. Other than flashing, no part of the cover systems shall extend beyond the outside edge of the steel walls. The existing clear walking space around the tanks shall be maintained.
14. A minimum of four bolts shall be used to connect each flange of every intersecting member to the gusset plates.
15. The cover system shall be designed with a walkway for personnel access to the top of the structure. The walkway shall be of non-skid material and be equipped with a handrail and cable clip for safety.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The erector must confirm the alignment and location of bearing plates, surfaces, brackets, saddles, etc. before placing aluminum cover framing members. All bearing surfaces must be clean and free from debris. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.
- B. The erector shall check the alignment and location of aluminum framing members before placing the secondary framing members.

- C. Inspection required by the structural engineer of record for the work of this Section.

3.2 ERECTION

- A. Erection shall proceed according to sequences as shown on the shop drawings.
- B. Shim aluminum framing only with approved shims. The use of scrap, off-fall, or other building materials as shims is not allowed.
- C. Install aluminum framing members on location, as shown on the approved shop drawings. Field modifications (cuts, copes, holes, etc.) other than work shown on the approved shop drawings are not allowed. Force fit is not allowed.
- D. Place aluminum panels on supporting members as shown on approved shop drawings. Refer to manufacturer's installation instructions.
- E. Attach aluminum panels to the aluminum supports as shown on the approved shop drawings. Refer to the manufacturer's installation instructions for proper fastener selection and driving techniques.
- F. Place and fasten aluminum flashing as shown on approved shop drawings.

3.3 INSTALLATION OF ALUMINUM DOME COVER

- A. Construction of the cover shall be in accordance with the manufacturer's instructions. The cover shall be constructed and erected by the manufacturer or the manufacturer's designated erector. A manufacturer's representative shall be present at the site during erection and installation to supervise the work. The representative shall certify in writing to the Engineer that the cover supports have been sufficiently prepared for the cover installation. Certify that the installation has been done in accordance with the manufacturer's recommendations.
- B. All work shall be executed by workers experienced and skilled in the erection and installation of the aluminum dome cover specified. All work shall be performed in accordance with approved shop drawings.

3.4 INSTALLATION OF APPURTENANT ITEMS

- A. Air Uptakes:
 - 1. Install the mounting bases for air uptakes in accordance with manufacturer's approved shop drawings.

3.5 CLEANING

- A. Clean products as required with soap and water and a soft bristled brush.
- B. Clean spills or stains that will not respond to soap and water with common solvents in accordance with the manufacturer's written instructions. Use solvents sparingly and only when

absolute necessary. Use all appropriate and necessary precautions and protections when using solvents.

3.6 FIELD QUALITY CONTROL

1. Test Measurements:

- A. Provide leak testing of the roof installation with Potable water in accordance with AWWA D108 Section 8.1, to verify that the underside of the roof is dry. The roof seams shall be leak tested by spraying the outside of the seams with water using a garden hose with a minimum 50 psig static head pressured at the nozzle, held at a distance between 3 and 6 feet.

END OF SECTION 133313

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SECTION 220517 - 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. Grout.
 - 3. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
 - 1. .

2.2 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: 5,000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. 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.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. 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.
 - 3. Using grout or silicone sealant, seal 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.

3.2 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.

3.3 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: PVC pipe sleeves.

END OF SECTION 220517

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SECTION 220523.12 - 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.
 - 2. Bronze 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 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. 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.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

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 Annex G and NSF 372 for valve materials for potable-water service.
- D. Make bronze valves with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- 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:
 - 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, One-Piece:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. KITZ Corporation.
 - b. WATTS; A Watts Water Technologies Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass or stainless steel.

- h. Ball: Chrome-plated brass or stainless steel.
- i. Port: Reduced.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Valve, Inc.
- b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
- c. DynaQuip Controls.
- d. FNW; Ferguson Enterprises, Inc.
- e. Hammond Valve.
- f. Jomar Valve.
- g. KITZ Corporation.
- h. Marwin Valve; Richards Industries.
- i. Milwaukee Valve Company.
- j. Red-White Valve Corp.
- k. Stockham; a Crane Co. brand.
- l. WATTS; A Watts Water Technologies Company.

2. Description:

- a. Standard: MSS SP-110.
- 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: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. WATTS; A Watts Water Technologies Company.
- f. Zurn Industries, LLC.

2. Description:

- a. Standard: MSS SP-110.

- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Bronze or brass.
- h. Ball: Chrome-plated brass.
- 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. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. Iron ball valves, Class 150.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Brass ball valve, one piece.
3. Brass ball valves, two-piece with full port and brass trim.
4. Bronze ball valves, two-piece with full port and bronze trim.

END OF SECTION 220523.12

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SECTION 220529 - 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. Fiberglass pipe hangers.
- 3. Fastener systems.
- 4. Equipment supports.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Fiberglass pipe supports.
 - 2. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers:
 - 1. Description: Similar to MSS SP-58, Type 1 steel pipe hanger, except hanger is made of fiberglass or fiberglass-reinforced resin.
 - 2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass or stainless steel.
 - 3. Flammability: ASTM D 635, ASTM E 84, UL 94.
- B. Strap-Type, Fiberglass Pipe Hangers:
 - 1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced resin.
 - a. Flammability: ASTM D 635, ASTM E 84, UL 94.
 - 2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.
- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 2. Indoor Applications: Stainless steel.
 3. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.6 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. 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: 5,000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. **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. **Fiberglass Pipe-Hanger Installation:** Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. **Equipment Support Installation:** Fabricate from welded-structural-steel shapes.
- F. 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.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. 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.

- I. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. 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.

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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. 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.
- H. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- I. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - 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. Warning signs and labels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Champion America.
 - d. Craftmark Pipe Markers.
 - e. Kolbi Pipe Marker Co.
 - f. LEM Products Inc.
 - g. Marking Services Inc.
 - h. Pipemarket.com; Brimar Industries, Inc.
 - i. Seton Identification Products; a Brady Corporation company.
 - j. emedco.
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 3. Letter Color: White.

4. Background Color: Black.
 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. 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.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. 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 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Champion America.
 4. Craftmark Pipe Markers.
 5. LEM Products Inc.
 6. Marking Services Inc.
 7. National Marker Company.
 8. Pipemarker.com; Brimar Industries, Inc.
 9. Seton Identification Products; a Brady Corporation company.
 10. Stranco, Inc.
 11. emedco.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- G. 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.
- H. Fasteners: Stainless steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces 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 and painting of 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 WARNING LABEL AND SIGN INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

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SECTION 221116 - 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. PVC piping.
 2. Piping joining materials.
 3. Transition fittings.
 4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.

- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF 372 for low lead.

2.2 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D1785, Schedule 80.
- B. PVC Socket Fittings: ASTM D2467 for Schedule 80.
- C. PVC Schedule 80 Threaded Fittings: ASTM D2464.

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, nonmetallic 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.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 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, provide products by one of the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.
 - c. Ford Meter Box Company, Inc. (The).

- d. Jay R. Smith Mfg Co; a division of Morris Group International.
- e. JCM Industries, Inc.
- f. Romac Industries, Inc.
- g. Smith-Blair, a Xylem brand.
- h. Viking Johnson.

2.5 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, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Central Plastics Company.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS.
 - h. Wilkins.
 - i. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig minimum at 180 degrees F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. WATTS.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 125 psig minimum at 180 degrees F.
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection; a Honeywell Company.
 - b. Grinnell G-Fire by Johnson Controls Company.
 - c. Matco-Norca.
 - d. Precision Plumbing Products.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig at 225 degrees F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- 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 underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping to permit valve servicing.
- L. 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.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages 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."

3.3 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. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. PVC Piping: Join according to ASTM D2855.
- E. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- 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.

3.5 DIELECTRIC FITTING INSTALLATION

- 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.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. 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.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping within 12 inches of each fitting.
- C. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 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. 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.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 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.

3.10 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 CLEANING

A. Clean non-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 procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- 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. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, plant water piping, NPS 3 and smaller, shall be one of the following:
 1. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 1. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller.
 2. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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. 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.
2. Install at equipment manufacturer's factory or ship 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.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 degrees 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. Service Factor: 1.15.
- D. 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.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material:
 - 1. Motor Frame Sizes 324T and Larger: Cast iron.
 - 2. Motor Frame Sizes Smaller than 324T: Rolled steel.

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:
 - 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. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 5. Provide grounding rings or straps on motors with variable frequency controller.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

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: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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.

2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230513

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC 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. Fastener systems.
 - 3. Equipment supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC 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 equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
2. Indoor Applications: stainless-steel.
3. Outdoor Applications: Stainless steel.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MATERIALS

A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

- B. Stainless Steel: ASTM A240/A240M.

PART 3 - EXECUTION

3.1 APPLICATION

- A. 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 the building structure.
- B.
- C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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 HANGER AND SUPPORT SCHEDULE

- A. Use stainless-steel pipe hangers and stainless steel attachments for applications.
- B. 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.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC 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.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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. Material and Thickness: aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
- 2. Letter Color: White.
- 3. Background Color: Black.
- 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 5. 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.

6. Fasteners: Stainless-steel rivets or self-tapping screws.
 7. 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces 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 and painting of 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.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 2. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
 - c. Heat-transfer coils.
 - 3. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.4 ACTION SUBMITTALS

- A. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete, and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.

- d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.

7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.8 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.9 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Engineer's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in degrees F.
 - e. Leaving-air temperature in degrees F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.

3.11 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner and Construction Manager.

- B. Engineer, Owner or Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

- E. If TAB work fails, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 3. If the second verification also fails, Owner or Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.

- F. Prepare test and inspection reports.

3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

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SECTION 232113 - HYDRONIC 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 pipe and fitting materials and joining methods for the following:
 1. Plastic pipe and fittings.
 2. Joining materials
 3. Transition fittings.
 4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 1. Pipe.
 2. Fittings.
 3. Joining materials.
 4. Bypass chemical feeder.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control reports.
- D. Welding inspection certificates
- E. Preconstruction Test Reports:
 1. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
 2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping, gaskets, and covering shall comply with ASTM 25/50, Flame Spread/Smoke Developed testing.
- B. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Cooling Coil Condensate-Drain Piping: 150 deg F.

2.2 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solvent Cements for PVC Piping: ASTM D2564. Include primer according to ASTM F656.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX USA LLC.
 - c. Uponor.
 - d. Viega LLC.
 - e. Lasco Fittings, Inc.
 - f. George Fischer Piping Systems
 - g. Spears Manufacturing Company.
2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX USA LLC.
 - c. NIBCO INC.
 - d. Spears Manufacturing Company.
 - e. Aquatherm.
 - f. Lasco Fittings, Inc.
 - g. George Fischer Piping Systems.
2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.5 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, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS; A Watts Water Technologies Company.
 - h. Wilkins.
 - i. Zurn Industries, LLC.
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, provide products by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. WATTS; A Watts Water Technologies Company.
 - c. Wilkins.
 - d. Zurn Industries, LLC.
 - e. CTS Flange
 - f. USA Federal Process Corp
 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, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. GPT; a division of EnPRO Industries.
 - e. Ramco Sealing Solutions
 - f. Flange Protection and Gasket, Inc.
 - g. Northtown Co
 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.
- E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Elster Perfection; Honeywell.
 - d. GPT; a division of EnPRO Industries.
 - e. Matco-Norca.
 - f. Precision Plumbing Products.

- g. Sioux Chief Manufacturing Company, Inc.
 - h. Victaulic Company.
 - i. MIFAB, Inc
 - j. Camco Manufacturing, Inc.
2. Description:
- a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

A.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

- M. Install air vents, consisting of a tee, 3/4-inch ball valve, short threaded nipple with cap or an automatic vent at all system high points.
- N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- P. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
 - 1.
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Route piping and install unions and shutoff valves to allow equipment removal without disturbing piping.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges and flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting and coupling.

3.5 PIPE 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. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. .
 3. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D2855.
 4. PVC Non-pressure Piping: Join according to ASTM D2855.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

END OF SECTION 232113

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SECTION 238113.13 - PACKAGED TERMINAL AIR-CONDITIONERS, OUTDOOR, WALL-MOUNTED 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. Section includes packaged, terminal, outdoor, wall-mounted air conditioners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For packaged, terminal air conditioners.
 - 1. Include plans, elevations, sections, details for wall penetrations, and attachments to other work.
 - 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For packaged, terminal air conditioners, for tests performed by manufacturer and witnessed by a qualified testing agency.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged, terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
 - 2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.
 - 3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Bard Manufacturing Company.
- B. Compu-Aire, Inc.
- C. Marvair.

2.2 MANUFACTURED UNITS

- A. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis and circuit breaker.
- B. 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.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- E. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.
- F. ASHRAE ERV Testing: Applicable requirements in ASHRAE 84.
- G. AHRI Rating: Applicable requirements in AHRI 1060.
- H. UL listed and ETL performance certified.

2.3 CHASSIS

- A. Cabinet: 16-gauge zinc coated steel with removable front panel with concealed latches.
 - 1. Mounting: On exterior wall.
 - 2. Discharge Grille: Extruded-aluminum discharge grille.
 - 3. Return Grille: Extruded-aluminum grille.
 - 4. Louvers: Extruded aluminum with enamel finish color.
 - 5. Finish: Baked enamel.
 - 6. Access Door: Hinged door in top of cabinet for access to controls.
 - 7. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
 - 8. Insulation: Cooling and heating sections fully insulated with 1-inch -thick fiberglass insulation.
 - 9. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 10. Wall Sleeves: Galvanized steel with polyester finish.

- B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with crankcase heater, liquid line filter dryer, externally equalized expansion valve, high-pressure switch, fan cycle, control, common alarm, vibration isolation, and overload protection.
 - 1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins.
 - 2. Accumulator.
 - 3. Constant-pressure expansion valve.
 - 4. Reversing valve.
 - 5. Charge: R-410A.

- C. Indoor Fan: Backward curved, centrifugal; with variable-speed motor(s) and positive-pressure ventilation damper with concealed manual operator.

- D. Filters: 2-inch, pleated, disposable MERV 8, serviceable from front of the unit.

- E. Condensate Drain: Coated galvanized-steel drain pan.
 - 1. Comply with ASHRAE 62.1 for drain pan construction and connections.

- F. Outdoor Fan: High-ambient, Forward curved, centrifugal, or propeller type with separate motor.
 - 1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Fan Motors: Permanently lubricated split capacitor.
 - b. 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.
 - c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.4 HEATING

- A. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

2.5 CONTROLS

- A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
 - 1. Low-Ambient Lockout Control: Prevents cooling-cycle operation below 40 degrees F outdoor air temperature if unit is provided with economizer
 - 2.
 - 3. Temperature-Limit Control: Prevents occupant from exceeding preset setup temperature.
- B. Economizer Operation (For Units that exceeds total cooling capacity of 54 MBH): Motorized intake-air damper controlled by an enthalpy sensor and a mixed-air sensor to provide natural cooling when the outdoor air temperature is favorable.
- C. Dual Unit Control (DUC): Hinged cover with two-stage heat/cool thermostat with individual heat/cool setpoints, adjustable interstage differentials and bimetallic elements. The control shall feature a solid-state timer with 1-2-4-8 day sequence, unit lead selector, Unit 1 and 2 power-on LEDs, Unit 1 or 2 lead unit LEDs, 48-hour program save on loss of power, industry standard connections, and 24-volt power from each unit. The DUC shall provide auto sequencing and displays on status and operating status parameters.
- D. Three-Phase Power Rotation Monitor: Three-phase monitoring to protect compressor from reverse rotation and to protect the unit from phase failure. Monitor manually reset.
- E. Ventilation:
 - 1. Extra Ventilation: Section internally mounted, allowing up to 100 percent outside air and exhaust air through the action of adjustable dampers to allow for economizer operation.
- F. Dehumidification Circuit: Supply-air stream, independent heat exchanger using a separate humidistat, hot gas three-way valve, separate desuperheating condenser circuit, and back drain orifice inserted between the reheat coil and suction line.

2.6 CAPACITIES AND CHARACTERISTICS

- A. Refer to Schedule on Drawings.

2.7 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."
- B. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.
- B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."
- C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Unit is level on base and is flashed in exterior wall.
 - 4. Unit casing has no visible damage.
 - 5. Compressor, air-cooled condenser coil, and fans have no visible damage.
 - 6. Labels are clearly visible.
 - 7. Controls are connected and operable.
 - 8. Shipping bolts, blocks, and tie-down straps are removed.
 - 9. Filters are installed and clean.
 - 10. Drain pan and drain line are installed correctly.
 - 11. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.
 - 12. Installation: Perform startup checks according to manufacturer's written instructions, including the following:
 - a. Lubricate bearings on fan.
 - b. Check fan-wheel rotation for correct direction without vibration and binding.
 - 13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After performance test, change filters.

E. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged, terminal air conditioners.

END OF SECTION 238113.13

SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

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. Removal of existing electrical equipment, wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
2. Disposal of materials.
3. Storage of removed materials.
4. Identification of utilities.
5. Salvaged items.
6. Protection of items to remain as indicated on Drawings.
7. Relocate existing equipment to accommodate construction.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Indicate demolition and removal sequence and location of salvageable items; location and construction of temporary work. Describe demolition removal procedures and schedule.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of capped utilities conduits and equipment abandoned in place.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Texas standard.

1.6 SCHEDULING

- A. Schedule work to coincide with new construction.
- B. Cease operations immediately when structure appears to be in danger and notify Engineer/Engineer. Do not resume operations until directed.

1.7 COORDINATION

- A. Conduct demolition to minimize interference with adjacent and occupied building areas.
- B. Coordinate demolition work with other disciplines.
- C. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.
- D. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition.
- E. Shut-down Periods:
 - 1. Arrange timing of shut-down periods of in service panels with Owner. Do not shut down any utility without prior written approval.
 - 2. Keep shut-down period to minimum or use intermittent period as directed by Owner.
 - 3. Maintain life-safety systems in full operation in occupied facilities, or provide notice minimum 3 days in advance.
- F. Identify salvage items in cooperation with Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.
- B. Verify termination points for demolished services.

3.2 PREPARATION

- A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.
- B. Temporary egress signage and emergency lighting

3.3 REMOVAL AND DISPOSAL OF LEGALLY REGULATED MATERIALS

- A. Material and equipment indicated to be removed and disposed of will become the Contractor's property. Dispose of material and equipment offsite, unless otherwise directed by the Owner. Provide the Owner with a receipt indicating the acceptable disposal of any legally regulated materials or equipment.

- B. Assume that the ballasts in each existing lighting fixture contain PCB's, unless specifically marked with a label indicating "No PCBs." Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility; pay all shipping, packaging and recycling costs.
- C. Remove, package, ship and dispose of PCBs, mercury and PCB/mercury contaminated equipment, in accordance with all State and Federal regulations. Retain the services of a firm licensed and regularly engaged in the removal of PCBs and PCB contaminated equipment. Retain a firm licensed in the State or States in which the contaminated material is handled, shipped and disposed of. Pay all fees associated with the removal of the contaminated material and equipment. Submit documentation indicating acceptable disposal.
- D. If PCB's or mercury contaminated equipment are discovered that were not identified; cease work on or about the equipment and notify the Engineer immediately.

3.4 DEMOLITION

- A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner before disturbing existing installation.
- B. Remove exposed abandoned conduit. Cut conduit flush with walls and floors, and patch surfaces.
- C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.
- D. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- E. Reconnect equipment being disturbed by renovation work and required for continue service.
- F. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
- G. Install temporary wiring and connections to maintain existing systems in service during construction.
- H. Perform work on energized equipment or circuits with experienced and trained personnel.
- I. Remove, relocate, and extend existing installations to accommodate new construction.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components. Cut embedded support elements flush with walls and floors.
- L. Clean and repair existing equipment to remain or to be reinstalled.
- M. Protect and retain power to existing active equipment remaining.

- N. Cap abandoned empty conduit at both ends.

3.5 EXISTING PANELBOARDS

- A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.
- B. Tag unused circuits as spare.
- C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.
- D. Remove existing wire no longer in use from panel to equipment.
- E. Provide new updated directories where more than three circuits have been modified or rewired.

3.6 SALVAGE ITEMS

- A. Remove and protect items indicated on Drawings to be salvaged and turn over to Owner
- B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.

3.7 REUSABLE ELECTRICAL EQUIPMENT

- A. Carefully remove equipment, materials, or fixtures which are to be reused.
- B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.
- C. Relocate existing lighting fixtures as indicated on Drawings. Clean fixtures and re-lamp. Test fixture to see if it is in good working condition before installation at new location.

3.8 CLEANING

- A. Remove demolished materials as work progresses. Legally dispose.
- B. Keep workplace neat.

3.9 PROTECTION OF FINISHED WORK

- A. Do not permit traffic over unprotected floor surface.

END OF SECTION 260505

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
2. Tray cable, Type TC, rated 600 V or less.
3. Variable Frequency Drive (VFD) cable.
4. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.
- B. VFD: Variable-frequency drive.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- 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. General Cable; Prysmian Group North America.
 2. Okonite Company (The).
 3. Southwire Company, LLC.
- C. Standards:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. RoHS compliant.
 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
 1. Type USE-2: Comply with UL 854.
 2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 3. Type XHHW-2: Comply with UL 44.
- F. Shield:
 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 TRAY CABLE, TYPE TC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- 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. General Cable; Prysmian Group North America.
 2. Okonite Company (The).

3. Southwire Company, LLC.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 1277.
4. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
5. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
6. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation: Type XHHW-2. Comply with UL 44.

G. Shield: None.

H. Overall Jacket: Chlorinated Polyethylene (CPE) Jacket.

I. Suitable for installation in a Class I, Division 2 hazardous location.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

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. 3M Electrical Products.
2. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
3. TE Connectivity Ltd.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with long barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Wire smaller than No.12 AWG will not be allowed.
- B. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type USE, single conductor in raceway.
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single or multi-conductors in raceway.
- E. Feeders in Cable Tray: Type XHHW-2, multi-conductor or single conductors larger than No. 1/0 AWG.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single or multi-conductors in raceway.
- H. Branch Circuits in Cable Tray: Type XHHW-2, multi-conductor or single conductors larger than No. 1/0 AWG.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- J. VFC Output Circuits: Type XHHW-2 in metal conduit Type TC-ER cable with dual tape shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Comply with requirements in Section 284621.12 "Addressable Fire-Alarm System - Performance" for connecting, terminating, and identifying wires and cables.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - 4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

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SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Control-circuit conductors.
 - 2. Identification products.
 - 3. Instrumentation cables.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.

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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.2 CONTROL-CIRCUIT CONDUCTORS

- 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. General Cable; Prysmian Group North America.
 - 2. Service Wire Co.
 - 3. Southwire Company, LLC.
- B. Class 1 Control Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway or Type TC, complying with UL 1277 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 - 1. Smoke control signaling and control circuits.

2.3 FIRE-ALARM WIRE AND CABLE

- 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. Genesis Cable Products; Honeywell International, Inc.
 - 2. Pysmian Cables and Systems; Pysmian Group North America.
 - 3. West Penn Wire; brand of Belden, Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, No. 18 AWG or size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 degrees C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Cable: NFPA 70, Type TC, copper conductors, Type XHHW conductor insulation, copper drain wire, with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.4 INSTRUMENTATION CABLE

- A. Paired Cable:
 - 1. One pair, No. 16 AWG, stranded and twisted on 2-in lay.
 - 2. PVC insulation, 600V rating, 90 degrees C rating.
 - 3. Shielded: 100 percent Aluminum/polyester foil with drain wire.
 - 4. PVC jacket with UL subject 1277, UL 1581 and manufacturer's identification.
 - 5. Manufacturers: Belden, or equal.
- B. Triad (three conductor) Cable:
 - 1. One triad No. 16AWG, stranded and twisted on 2-in lay.
 - 2. PVC insulation, 600V rating, 90 degrees C rating.
 - 3. Shielded: 100 percent Aluminum/polyester foil with drain wire.
 - 4. PVC jacket with UL subject 1277, UL 1581 and manufacturer's identification.
 - 5. Manufacturers: Belden, or equal.
- C. Multiple pair cables (where shown on Drawings)
 - 1. Multiple, No. 16 AWG, stranded and twisted on 2-in lay.
 - 2. PVC insulation, 600V rating, 90 degrees C rating.

3. Shielded: 100 percent Aluminum/polyester foil with overall shield and drain wire.
4. PVC jacket with UL subject 1277, UL 1581 and manufacturer's identification.
5. Manufacturers: Belden, or equal.

2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
 1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 1. Outlet boxes for cables shall be no smaller than 4 inches square by 1-1/2 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 2. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 1. Comply with TIA-568-C Series of standards.
 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware.
3. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits; No 14 AWG.
 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

- A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL 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 grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. Include the following:
 - a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Ground rods.
 - 3) Ground rings.
 - 4) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.

- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
- 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

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. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 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. Burndy; Hubbell Incorporated, Construction and Energy.
 2. ERICO; nVent.
 3. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

2.3 CONDUCTORS

- A. Insulated Conductors: tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B3.
 2. Stranded Conductors: ASTM B8.
 3. Tinned Conductors: ASTM B33.
 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- K. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- L. Straps: Solid copper, copper lugs. Rated for 600 A.
- M. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- N. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

2.6 EXOTHERMIC WELDING

- A. Exothermic welding shall be by CADWELD process, or equal. Molds and powder shall be furnished by the same manufacturer and sized and selected per manufacturer's instructions for specific combination of conductors and connected items.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 30 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- F. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Separately derived systems such as transformers or generators (if identified as such) shall bond neutral and ground together with a bonding jumper at the equipment in accordance with NEC 250.102. Connection to the grounding electrode system via the electrode grounding conductor shall be in accordance with NEC Table 250.66 or as shown on the Drawings.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.6 INSTALLATION

- A. Grounding Electrode Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - 1. Where conductors pass through floor slabs, walls, etc., they shall be installed in conduit or sleeved.
 - 2. Conductors subject to mechanical damage shall be protected by non-ferrous conduit to avoid a choke effect for fault currents.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
 - 4. Rods shall be installed vertically and not allowed to be deformed or driven at an angle. Where driving is difficult or where rock is encountered, Contractor shall use purpose-designed drilling equipment, install the rod into the drilled hole and backfill around rod using ground enhancement material (GEM) mixed with water to form a slurry in accordance with the Manufacturer's instructions.

- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart or as shown on the Contract Drawings.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of area or item indicated.
 - 1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building's foundation.
 - 3. Lay all underground conductors slack, and where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard.

- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; Article 250.52 and connect to grounding electrode system.
- K. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL 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. Steel slotted support systems.
- 2. Aluminum slotted support systems.
- 3. Stainless steel slotted support systems.
- 4. Conduit and cable support devices.
- 5. Support for conductors in vertical conduit.
- 6. Structural steel for fabricated supports and restraints.
- 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
- 8. Fabricated metal equipment support assemblies.
- 9. Delegated Design.

- B. Related Requirements:

- 1. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for products and installation requirements necessary for anchoring systems.

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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.

2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
1. Hangers. Include product data for components.
 2. Slotted support systems.
 3. Equipment supports.
 4. 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.

1.4 DELEGATED DESIGN SUBMITTALS

- A. For hangers and supports for electrical systems:
1. Include design calculations and details of hangers.

1.5 INFORMATIONAL SUBMITTALS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized iron or steel.
- B. Stainless steel channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations unless noted otherwise.
- C. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.
- D. Conduit Supports:
1. Trapezes:
 - a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.

- b. Stainless steel beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
 2. Flush Mounted Supports:
 - a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.
 - b. Stainless steel channels, struts or fiberglass channels, struts with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
 3. Conduit Racks:
 - a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.
 - b. Stainless steel conduit racks with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
 4. Conduit Hangers:
 - a. In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel.
 - b. Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
- E. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
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. CADDY; brand of nVent Electrical plc.
 - b. Cooper B-line; brand of Eaton, Electrical Sector.
 - c. Unistrut; Atkore International.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel, Stainless steel, Type 316, [PVC Coated Steel].
 4. Channel Width: 1-5/8 inches.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- F. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum (10-mm-) diameter holes at a maximum of (200 mm) o.c. in at least one surface.
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. Eaton.
 - b. Unistrut; Atkore International.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Material: 6063-T5 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 5. Channel Width: 1-5/8 inches.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- G. Conduit and Cable Support Devices: Steel or Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- H. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- I. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 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) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- 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) Cooper B-line; brand of Eaton, Electrical Sector.
 - 2) Hilti, Inc.
 - 3) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A F3125/F3125M, Grade A325 (Grade A325M).
6. Toggle Bolts: Stainless steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 102.
 4. NECA 105.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, according to NFPA 70.
- C. 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.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as 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 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.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL 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. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 260529 "Hangers and Supports for Electrical Systems" for conduit supports.
3. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. GRS: Galvanized rigid steel conduit. See GRC.
- D. RAC: Rigid aluminum conduit. See ARC.
- E. SSC: Stainless steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 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. Allied Tube & Conduit; Atkore International.
 - b. Anaconda Sealtite; Anamet Electrical, Inc.
 - c. Patriot Aluminum Products, LLC.
 - d. Wheatland Tube; Zekelman Industries.
 - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. GRC: Comply with ANSI C80.1 and UL 6.
 - 4. ARC: Comply with ANSI C80.5 and UL 6A.
 - 5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
 - 6. EMT: Comply with ANSI C80.3 and UL 797.
 - 7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
 - a. Suitable for use in Class I, Division 2 locations.
- B. Metal 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. Allied Tube & Conduit; Atkore International.
 - b. Anaconda Sealtite; Anamet Electrical, Inc.

- c. Patriot Aluminum Products, LLC.
 - d. Wheatland Tube; Zekelman Industries.
 - e. Crouse-Hinds Co.
 - f. O.Z./Gedney Co.
 - g. Appleton Electric Co.
 - h. Thomas & Betts.
2. Comply with NEMA FB 1 and UL 514B.
 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 6. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 7. LFMC Fittings: Provide with insulated throat. Suitable for use in Class I, Division 2 hazardous locations
 8. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 9. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

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. CANTEX INC.
 - b. Carlon Corp.
 - c. Allied Tube & Conduit.
 - d. Thomas & Betts.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

B. Nonmetallic 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. CANTEX INC.
 - b. Carlon Corp.
 - c. Allied Tube & Conduit.
 - d. Thomas & Betts.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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. B-line, an Eaton business.
 2. Hoffman; a brand of nVent
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 gasketed painted steel or Type 4X gasketed type 316 stainless steel unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Hardware: Stainless steel.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 MISCELLANEOUS FITTINGS

- A. Flexible Couplings:
 1. Manufacturers: Provide products by one of the following:
 - a. "Type ECGJH," by the Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. Killark Electric Manufacturing Co.
 - d. Or equal.
- B. Conduit Hubs:
 1. Manufacturers: Provide products by one of the following:

- a. Myers Electric Products, Inc.
 - b. Or equal.

- C. Conduit Wall Seals for New Concrete Walls Below Grade:
 1. Products: Provide one of the following:
 - a. O.Z./Gedney Co., Type WSK; Linkseal.
 - b. Spring City Electrical Manufacturing Co., Type WDP.
 - c. Or equal.

- D. Conduit Wall Seals for Cored Holes:
 1. Products: Provide one of the following:
 - a. Type CSMC as manufactured by the O.Z./Gedney Co.
 - b. Or equal.

- E. Conduit Wall and Floor Seals For Sleeved Openings:
 1. Products: Provide one of the following:
 - a. Type CSMI as manufactured by the O.Z./Gedney Co.
 - b. Or equal.

- F. Combination Expansion-Deflection Fittings Embedded in Concrete:
 1. Products: Provide one of the following:
 - a. Type XD as manufactured by the Crouse-Hinds Co.
 - b. Type DX as manufactured by O.Z./Gedney Co.
 - c. Type DF as manufactured by Appleton Electric Co.
 - d. Or equal.

- G. Combination Expansion-Deflection Fittings Installed Exposed:
 1. Products: Provide one of the following:
 - a. Type XJGD as manufactured by Crouse-Hinds Co.
 - b. Type AXDX as manufactured by O.Z. Gedney Co.
 - c. Type AFDF as manufactured by Hubbell/Killark.
 - d. Or equal.

- H. Explosion Proof Fittings:
 1. Manufacturers: Provide products by one of the following:
 - a. Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. O.Z./Gedney Co.
 - d. Or equal.

- I. Conduit Sealing Bushings:
 - 1. Products: Provide one of the following:
 - a. O.Z./Gedney, Type CSB.
 - b. Or equal.
- J. Grounding Bushings: Malleable iron with integral insulated throat rated for 300 degrees F, with solderless lugs.
 - 1. Products: Provide one of the following:
 - a. Crouse Hinds/Cooper, Series HGLL.
 - b. Appleton, Series GIB.
 - c. O.Z./Gedney, Type HBLG.
 - d. Or equal.

2.5 BOXES, ENCLOSURES, AND CABINETS (NON-HAZARDOUS LOCATIONS)

- 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. Crouse-Hinds; Eaton, Electrical Sector.
 - 2. Hoffman; nVent.
 - 3. Hubbell Incorporated.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy with steel conduit or aluminum with aluminum conduit, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum galvanized, cast iron with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.

- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 gasketed painted steel or Type 4X gasketed type 316 stainless steel with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Minimum 14 gauge steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1, Type 3R galvanized-steel box or Type 4X gasketed type 316 stainless steel with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 TERMINAL BLOCKS

- 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. Eaton.
 - 2. Rockwell Automation.
 - 3. TE Connectivity.
- B. Description:
 - 1. Terminal Blocks: NEMA ICS 4.
 - 2. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
 - 3. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
 - 4. Furnish ground bus terminal block, with each connector bonded to enclosure.

2.7 HAZARDOUS (CLASSIFIED) LOCATION BOXES

- A. Design explosion-proof boxes for Class 1, Group D, Division 1 hazardous locations, provided with O-ring seals to meet NEMA 4 requirements.
 - 1. Boxes and Covers: Aluminum, with stainless steel hinges and stainless steel bolts.
 - 2. Manufacturer: Provide products by one of the following:
 - a. "Type EJB-N4," by the Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. Adalet-PLM.

- d. Or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: ARC. PVC-coated rigid steel in chemical storage and handling areas.
 2. Concealed Conduit, Aboveground: GRC or RNC, Type EPC-40-PVC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased. GRC, concrete encased for Class 2 and 3 signal wiring, fire alarm, 4-20 mA instrumentation cables, and non-fiber data highway.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA rated, suitable for installed location and enclosure type as noted on the Drawings.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, air conditioned area, not Subject to Physical Damage: EMT, GRC or ARC.
 2. Exposed and Subject to Severe Physical Damage: ARC.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: ARC.
 5. Boxes and Enclosures: NEMA rated, suitable for installed location and enclosure type as noted on the Drawings.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 degrees F.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions or as indicated on Structural Drawings.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
 - 5. Change from RNC to PVC coated GRC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
 - 1. Use RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 degrees F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 degrees F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 degrees F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit forequipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- CC. Locate boxes so that cover or plate will not span different building finishes.
- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. A maximum continuous run of conduit shall not exceed 300 feet and shall be reduced by 75 feet for each 90-degree elbow.

- GG. Provide a 4-inch concrete housekeeping pad at all slab and grade penetrations. Provide a 45 degree, 3/4-inch chamfer at all exposed edges.
- HH. Protect metallic finish conduit installed in contact with concrete or below grade with two coats of bitumastic paint, heat shrink tubing, or approved equivalent.
- II. In hazardous locations, seal conduits terminating at boxes enclosing circuit opening equipment at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits. Similarly seal all conduits leading from or entering hazardous locations at points of exit or entrance. Seal exposed conduits passing through hazardous locations at both the entrance to and the exit from the hazardous locations. A sealing compound installation schedule shall be presented to the Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- JJ. Install conduit sealing and drain fittings in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.
- KK. Install conduit sealing and drain fittings on all conduits entering and leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are: rooms where chlorine, ammonia, and ozone are stored, generated, or heated. A sealing compound installation schedule shall be presented to Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- LL. Use liquid-tight flexible metal conduit for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. The length of liquid-tight flexible metal conduit shall not exceed 36 inches when used for vibration isolation and shall not exceed 72 inches in length when attaching to luminaires. Non-metallic flexible conduit shall only be allowed for use with rigid PVC conduit systems.
- MM. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260536 - CABLE TRAYS FOR ELECTRICAL 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. Ladder cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 DELEGATED-DESIGN SUBMITTALS

- A. Section 014000 "Quality Requirements" for additional delegated design requirements.
- B. Qualifications Statement: Submit qualifications for licensed professional.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Delegated Design Engineer: Licensed professional engineer experienced in design of specified Work and licensed in the State of Texas of Project location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

- 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. B-line; Eaton, Electrical Sector.
 - 2. Cope; Atkore International.
 - 3. MP Husky USA Cable Tray & Cable Bus.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: As indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 20 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 20C.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Aluminum:
 - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
 - b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
 - c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- D. Cable Tray fittings to be provided by the same manufacturer.
- E. Provide covers where shown on Drawings.

2.5 WARNING SIGNS

- A. Lettering: 1-1/2-inch- high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Comply with Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable tray and support systems according to NEMA VE 2.
- B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Do not install more than one cable tray splice between supports.

- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.
- U. Install permanent covers and cover clamps, if used, after installing cable.
- V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie mineral-insulated cables down every 36 inches where required to provide a two-hour fire rating and every 72 inches elsewhere.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorqued in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL 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. Duct accessories.
2. Precast concrete handholes.
3. Polymer concrete handholes and boxes with polymer concrete cover.
4. Precast manholes.

B. Related Requirements:

1. Section 033000 “Cast-in-Place Concrete” for encased ductbank concrete mix.
2. Section 260533 “Raceways and Boxes for Electrical System” for metal and nonmetallic conduits.
3. Section 260553 “Identification for Electrical Systems” for underground warning tape.
4. All trenching, excavation and backfilling, including gravel and sand bedding and surface restoration are specified in Division 31, but the responsibility of furnishing and installing the material shall be that of this Section.
5. Groundwater control is included in Division 31.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 1. Two or more ducts installed in parallel, with or without additional casing materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including spacers and miscellaneous components.
 - 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for manholes, handholes, boxes.

- B. Shop Drawings:
 - 1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - h. Include joint details.

 - 2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Include buoyancy calculations.
 - 3. Drawings and calculations shall be signed and sealed by a qualified professional engineer.

- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

- C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 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. Allied Tube & Conduit; Atkore International.
 - b. Cantex Inc.
 - c. IPEX USA LLC.

- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
- C. Concrete duct bank
 - 1. Concrete mix: Comply with requirements for concrete mix specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Color:
 - a. Apply red dye mixed with water to the top of the concrete duct bank with a sprayer while the concrete wet (prior to curing).

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- 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. Oldcastle Infrastructure Inc.; CRH Americas.
 - 2. Utility Concrete Products, LLC.
 - 3. Utility Vault Co.
- C. Comply with ASTM C858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "ELECTRIC."
- G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - 1. Extension shall provide increased depth of 12 inches.
 - 2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
- I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Center window location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 5. Knockout panels shall be 1-1/2 to 2 inches thick.
- K. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.3 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- 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. Oldcastle Infrastructure Inc.; CRH Americas.
 2. Utility Concrete Products, LLC.
 3. Utility Vault Co.
- C. Comply with ASTM C858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
1. Center window location.
 2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 5. Knockout panels shall be 1-1/2 to 2 inches thick.
- F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.
- D. Stub-ups: Concrete-encased PVC-coated GRC or PVC-coated ARC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Cover design load shall not exceed the design load of the handhole or box.

- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures.

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Where bends in raceways are required, use manufactured long radius elbows, sweeps and offsets with a minimum radius as required by the cable manufacturer to meet the bending radius of the cables. Provide rigid steel or PVC-coated metal for elbows and sweeps.
 - 1. Duct shall have maximum of three 90-degree bends or the total of all bends shall be no more 270 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 degrees C. Where environmental temperatures are calculated to rise above 40 degrees C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

- G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
- H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- J. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.
- K. Concrete-Encased Ducts and Duct Bank:
 - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 6 inches wider than duct on each side.
 - 3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 - 4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - 5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 6. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

- 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
 7. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 8. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 9. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
 10. Concrete Mix: Comply with requirements for concrete mix specified in Section 033000 "Cast-in-Place Concrete."
 11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- L. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms for pipes less than 6 inches in nominal diameter.
 2. Width: Excavate trench 12 inches wider than duct on each side.
 3. Width: Excavate trench 3 inches wider than duct on each side.
 4. Depth: Install top of duct at least 24 inches below finished grade unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.
 6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 8. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

9. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
10. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction
 - a. Place minimum 6 inches of engineered fill above concrete encasement of duct.

- M. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below frost line.
 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation in accordance with manufacturer's instructions. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation in accordance with manufacturer's instructions. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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 for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 3/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 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. BWM Company.
 - b. CALPICO, Inc.
 - c. GPT; a division of EnPRO Industries.
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel, with corrosion resistant coating.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; recommended 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.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.

- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 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 waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL 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. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.
10. Delegated Design.

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 electrical identification products.

- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.4 DELEGATED DESIGN SUBMITTALS

- A. For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer, as defined in Sections 013300 “Submittal Procedures” and 014000 “Quality Requirements”, to submit the items listed in the DELEGATED DESIGN SUBMITTALS Article.
- B. Comply with ASME A13.1 and IEEE C2.
- C. Comply with NFPA 70.
- D. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- E. Comply with ANSI Z535.4 for safety signs and labels.
- F. Comply with NFPA 70E and Section 260573 "Power System Studies" requirements for arc-flash warning labels.
- G. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Color-Coding for Identification, 600 V or Less: Use colors listed below for conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - 3. Colors for 240/120-V Circuits (Single Phase):
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White.
 - 4. Colors for 240 Δ /120-V Circuits (Three Phase, Four Wire, high leg, center tap):
 - a. Phase A: Black.
 - b. Phase B: Orange (high leg).
 - c. Phase C: Blue.

- d. Neutral: White.
5. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 6. Colors for DC Circuits:
 - a. Positive: Red.
 - b. Negative: Black.
 - c. Ground: White or Gray.
 7. Color for Equipment Grounds: Green.
 8. Colors for Isolated Grounds: Green with two or more yellow stripes.
- B. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.
- C. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- D. Equipment Identification and Source Nameplates:
1. Black letters on a white field.
 2. Nameplates shall be engraved, laminated plastic, not less than 1/16-inch thick by ¾-inch by 2-1/2-inch with 3/16-inch-high lettering.
 3. All electrical equipment furnished under Divisions 26 and 27 and all equipment control panels furnished under other Divisions shall include equipment identification nameplates. Equipment includes switchgear, switchboards, motor control centers, panelboards, transformers, disconnect switches, separately mounted motor controllers, transfer switches, control panels, named terminal cabinets, etc. The designation of the equipment shall correspond to the designation shown on the Drawings.
 4. Equipment identified in the previous paragraph above shall also include a nameplate with the power source identified
- E. Device Identification Labels:
1. Black letters on a white field.
 2. Labels shall be self-adhesive type and machine generated with ¼-inch high letters.
 3. All receptacles, wall switches, lighting fixtures, photocells, emergency lights, exit lights, instruments, etc. shall be identified with the panel and circuit to which it is connected.

2.3 LABELS

- A. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 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. Panduit Corp.
 - c. Seton Identification.
 - 2. Refer to Section 260573 “Power System Studies.”

2.4 BANDS AND TUBES

- A. Heat-Shrink Preprinted Tubes and Markers: Flame-retardant polyolefin tubes and markers with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 degrees F. Comply with UL 224.
 - 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. Panduit Corp.

2.5 TAPES

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - 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. Ideal Industries, Inc.
 - b. Marking Services Inc.
 - c. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
 - 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. Carlton Industries, LP.

c. Marking Services Inc.

C. Underground-Line Warning Tape:

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. Ideal Industries, Inc.
 - c. Seton Identification Products; a Brady Corporation company.
2. **Tape:**
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines by either conductive or inductive location techniques.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. **Color and Printing:**
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
4. **Tag:**
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 6 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 28 lb/1000 sq. ft.
 - f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

2.6 TAGS

- A. **Plastic Engraved Tags:** 1/8 inch, black with white engraved legend, punched for use with self-locking cable tie fastener.
 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. Carlton Industries, LP.
 - c. Marking Services Inc.
1. Metal Tags: Embossed Type 316 stainless steel, 0.01-inch thick, punched for use with tie fastener. Secure with 0.048-inch diameter stainless steel band fastened with compression wire clamps. Panduit Corporation.
 2. Or equal.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Panduit Corp.

2.7 CABLE TIES

- 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. Ideal Industries, Inc.
 2. Marking Services Inc.
 3. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Degrees F according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 degrees F.
 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Degrees F according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 degrees F.
 4. Color: Black.
- D. Cable Tray Cable Ties: Single cable cleat with LSF pad, by B-line or equal.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Cables: Identification shall completely encircle cable. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, and cable.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

- J. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "POWER."
 - 2. "CONTROL."
- K. Heat-Shrink, Preprinted Tubes and Markers: Secure tight to surface at a location with high visibility and accessibility
- L. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- M. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- N. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- O. Metal Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using stainless steel tie.
- P. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties. In Spaces Handling Environmental Air: Plenum rated.
- Q. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.
- R. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- S. Equipment Nameplates:

1. Nameplates shall be screw mounted to NEMA 1 enclosures.
2. Nameplates shall be bonded to all other enclosure types using an epoxy or similar waterproof adhesive.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways, Armored and Metal-Clad Cables: Plastic tags.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
 3. "CONTROL."
- E. Power-Circuit Conductor Identification: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase, and a separate plastic tags with the circuit designation.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- G. Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes and markers with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach heat-shrink preprinted tubes to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: heat-shrink preprinted tubes that is uniform and consistent with system used by manufacturer for factory-installed connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- M. Arc Flash Warning Labeling: Self-adhesive labels.
- N. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- O. Equipment Identification Labels:
 - 1. Indoor Equipment: Engraved, laminated plastic.
 - 2. Outdoor Equipment: Engraved, laminated plastic.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power-transfer equipment.
 - p. Remote-controlled switches, dimmer modules, and control devices.
 - q. Power-generating units.
 - r. Monitoring and control equipment.
- P. Junction and Pull Box Nameplates:

1. All voltages (e.g., 480 volts, 120 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Provide Signs with red background with white engraved lettering. Provide lettering a minimum of 1 inch high.

Q. Panelboard Identification:

1. Label branch circuit wires with associated pole number using vinyl cloth wrap around labels.
2. Provide typed as built circuit directories giving location and nature of load served. Install circuit directories in each panelboard.
3. Provide each panelboard with two nameplates. The first shall be provided by the panelboard manufacturer and shall identify the panel. The second shall be field installed by the Contractor to identify the panel's upstream power source.

END OF SECTION 260553

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SECTION 260573 - POWER SYSTEM STUDIES

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 a computer-based study for:
 - 1. Short circuit report.
 - 2. Protective device coordination report.
 - 3. Motor starting report.
 - 4. Arc flash report.
 - 5. Harmonic analysis report.
- B. Study encompasses the power distribution system of the City of Georgetown San Gabriel Wastewater Treatment Plant. Facility is located at:
 - 1. San Gabriel WWTP: 1107 N. College St., Georgetown, TX 78626..
- C. Study includes the electric utility company's protective devices, emergency generators, service entrance equipment and distribution to plant loads. All power distribution to that point whether existing or new is included. Equipment included, but not limited to:
 - 1. Substations and distribution.
 - 2. Switchgear, switchboards, and panelboards.
 - 3. Motor control centers.
 - 4. Variable frequency controllers.
 - 5. Disconnect switches.
 - 6. Transfer switches.
 - 7. 480V control panels.
- D. The local electric utility is Georgetown Utility Systems.
- E. Obtain all data necessary to perform the study. Data included, but not limited to:
 - 1. Up to date one-line diagrams.
 - 2. Equipment data.
 - 3. Cable sizes and lengths.
 - 4. Existing protective device settings.
 - 5. Electric utility information: available fault current, protective device equipment information and settings, X/R ratios, transformer impedances and ratings.

1.3 DEFINITIONS

- A. Boundary, Arc Flash: When an arc flash hazard exists, an approach limit from an arc source at which the incident energy equals 1.2 cal/cm² (5 J/cm²).
- B. Boundary, Limited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
- C. Boundary, Restricted Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- E. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- F. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- G. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- H. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- I. Preliminary Short Circuit Report: Report that includes the maximum available utility fault current, proposed equipment, and existing equipment to determine if new equipment may be released for manufacturing and existing equipment is adequate for the calculated short circuit levels.
- J. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- K. SCCR: Short-circuit current rating.
- L. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- M. Single-Line Diagram: See "One-Line Diagram."
- N. Supplier: The person, firm or corporation identified as such to provide the power system study and means the Supplier or its authorized agent. See also Power Systems Analysis Specialist.

1.4 ACTION SUBMITTALS

- A. Supplier qualifications per Quality Assurance paragraph. Submit prior to starting study. Include the following:
 - 1. Brief description of each qualifying study.
 - 2. Name of owner of installation on which study was performed with address, telephone number, and contact person.
 - 3. Date of study.
 - 4. Any other information indicating the firm's experiences and ability to perform the work and business status.
- B. Preliminary Power System Study Report. Report must be approved prior to release for manufacture of major electrical equipment including but not limited to switchgear, switchboards, distribution panels, and motor control centers. Fault data from the utility must be included and not assumed or submittal will be rejected.
- C. Final Power System Study Report. Report must be approved prior to energization of new major electrical equipment. Revise study as required for changes during construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. If requested, Product Certificates: For power system study software, certifying compliance with IEEE 399, IEEE 1584 and NFPA 70E.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Final power system study updated with any changes made after equipment start-up.
- B. Digital computer files with full read-write access of the complete power system model and library.

1.7 QUALITY ASSURANCE

- A. Perform Study using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

- D. Power System Analysis Software Qualifications:
 - 1. Design computer program to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 - 2. Develop computer program under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
 - 3. Complies with IEEE 399, IEEE 141, IEEE 242, IEEE 519, IEEE 1015, and IEEE 1584 as applicable to the project scope.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located and has regularly engaged in this electrical engineering study specialty for minimum of five years and has performed at least three projects of similar complexity to this project within the last three years. Perform all elements of the study under the direct supervision and control of this professional engineer.
- F. Power System Study Certification: Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Acceptable Software:
 - 1. SKM System Analysis, Inc.: Power*Tools.
 - 2. Operation Technology, Inc.: ETAP (Electrical Transient Analyzer Program).
 - 3. EasyPower, Inc.: EasyPower.
 - 4. Or equal.

2.2 POWER SYSTEM STUDY REPORT GENERAL REQUIREMENTS

- A. Except for one-line diagrams, standard 8 1/2-inch by 11-inch pages, with total pages numbered.
- B. Electronic PDF format copy with electronic bookmarks for each section.
- C. Signed and sealed by a professional engineer registered in the state in which the project is located.
- D. Organized in the following order:
 - 1. Executive Summary.

2. Short Circuit Analysis.
 3. Short Circuit Computer Printout.
 4. Protective Device Coordination.
 5. Motor Starting.
 6. Arc Flash Hazard Analysis.
 7. Harmonic Analysis.
 8. Utility Data.
 9. Modeled One Line Diagrams.
- E. Information on one-line diagrams, legible when printed at 11-inch x 17-inch. Show the following:
1. Protective device designations and ampere ratings.
 2. Conductor types, sizes, and lengths.
 3. Transformer kilovolt ampere (kVA), impedance, and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 6. Derating factors and environmental conditions.
 7. Any revisions to electrical equipment required by the study.
- F. Identifiers between the one-line diagram, short circuit study, coordination study, and arc flash study to be the same.
- G. Include copies of correspondence with electric utility under utility data section of report. Correspondence to include names and contact information.

2.3 EXECUTIVE SUMMARY

- A. Include summary of distribution system, information received from electric utility, major assumptions, adequacy of equipment to safely clear or close on any fault, identify problem areas and recommendations for resolving problem areas.

2.4 SHORT CIRCUIT

- A. Comply with IEEE 399 and IEEE 551 (new 3002 series).
- B. Include normal utility powered configuration, on-site generation configuration, and alternate modes of operation (i.e. alternate utility configuration, bus ties closed).
- C. Include minimum and maximum possible fault conditions. Address three-phase bolted as well as ground fault conditions.
- D. Consider the fault contribution of all motors operating during the maximum demand condition of the motors.
- E. Calculate short-circuit momentary duties and interrupting duties based on an assumed bolted three-phase short circuit at each high and medium voltage switchgear bus and controller, low voltage switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard and other significant locations throughout the systems. Include the

X/R ratios, asymmetry factors, KVA and symmetrical fault-current in the short circuit tabulations. Provide a ground fault current study for the same system areas. Include in tabulations fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault-currents.

- F. Include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.
- G. Identify available fault current at each bus and evaluate system elements including but not limited to equipment, protective devices, and cables.
- H. Base current transformers' ratio and burden calculations on a 10 percent maximum ratio error per IEEE C57.13. Identify current transformers that will not allow the protective devices to operate within acceptable IEEE error margins and recommend corrective action.
- I. List momentary, interrupting, and/or withstand rating of all key elements of the distribution system along with the maximum available fault current in tabular form and clearly indicate the adequacy of the element with PASS / FAIL designation.
- J. Short Circuit Computer Printout:
 - 1. Calculations shall be in sufficient detail for easy review.
 - 2. Back up calculations shall become part of the final report.

2.5 PROTECTIVE DEVICE COORDINATION

- A. Comply with IEEE 242 (new 3004 series).
- B. Utilize results from the short circuit study and balance the competing objectives of protection and continuity of service for the system specified, considering the basic factors of sensitivity, selectivity and speed. Include all system protective devices in the coordination analysis, not just overcurrent protective devices. This includes, but is not limited to under and over voltage protective relays, frequency relays, differential relays and reverse power relays.
- C. Show graphic indication of coordination between protective devices in the form of full color time-current coordination (TCC) plots with each protective device curve in a unique color for easy review.
- D. Provide separate TCC plots for each mode of operation. Provide separate TCC plots for "normal" and "stand by" operation. Show maximum fault values in each case. Both power sources shown on one plot is unacceptable.
- E. Provide separate TCC for phase over-current and ground fault.
- F. Show no more than six devices on one TCC. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots to provide cross-reference. Designate each TCC with a unique identifier and include each TCC identifier and descriptive title in the study's table of contents.

- G. Include in each TCC the following as applicable:
1. TCC name and description.
 2. One-line diagram.
 3. Identifiers on one-line diagram and curves.
 4. Significant motor starting characteristics.
 5. Appropriate NEC protection points.
 6. Appropriate ANSI/IEEE protection points.
 7. Magnetizing inrush points of transformers.
 8. Transformer damage curves.
 9. Complete operating bands for low voltage circuit breaker trip devices and fuses.
 10. Relay coil taps, time-dial settings and pickup settings.
 11. Significant symmetrical and asymmetrical fault currents.
 12. Power cable withstand curves.
 13. Generator short circuit decrement and thermal limit curves.
- H. Terminate device characteristic curve on TCC at a point reflecting the maximum symmetrical or asymmetrical fault current to which that device is exposed, based on the short circuit study.
- I. Select each primary protective device for a delta-to-wye-connected transformer so the characteristic or operating band is within the transformer parameters; where feasible, include a parameter equivalent to 58 percent of the ANSI C37.91 withstand curve to afford protection for secondary line-to-ground faults.
- J. Separate low voltage power circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults.
- K. Separate protective relays by a 0.3-second time margin for the maximum 3 phase fault conditions to assure proper selectivity.
- L. Optimize settings for breakers and relays to provide the most effective protection practicable for all modes and power sources.
- M. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and/or power distribution panelboard. Include all adjustable setting ground fault protective devices.
- N. Provide tabulations of recommended settings for all protective devices. Where devices are existing, highlight any changes from the existing setting to the proposed recommended setting.
- O. Provide all information required to program/set multifunction solid state relays.

2.6 MOTOR STARTING

- A. Comply with IEEE 141 (new IEEE 3001 series) for recommended light flicker limits and IEEE 3002.7 for motor starting studies.
- B. Provide motor starting study for all large electric drives (100 horsepower and larger). Include all operating modes.

- C. Identify any concerns about voltage drop or power inrush limitations due to the starting of motors.

2.7 ARC FLASH HAZARD

- A. Comply with IEEE 1584, NFPA 70, and NFPA 70E as applicable.
- B. Utilize short circuit and protective device coordination results to provide arc flash hazard analysis. Perform calculations in accordance with IEEE 1584.
- C. Calculate the incident energy levels at each faulted bus for each mode of operation and for both maximum and minimum fault currents.
- D. Include calculations at line side and load side of main breakers, where applicable.
- E. Provide tabular report for all modes and conditions and include “worst case” summary. Use the “worst case” to generate the arc flash labels. Include:
 - 1. Fault location.
 - 2. Arcing fault magnitude.
 - 3. Protective device clearing time.
 - 4. Duration of the arc.
 - 5. Arc flash boundary.
 - 6. Working distance.
 - 7. Incident energy.
 - 8. Electrode configuration.
- F. Highlight any available incident energy over 40 cal/cm² and provide recommendations to mitigate the hazard.
- G. Arc Flash Labels:
 - 1. Machine printed, 4-inch x 4-inch (nominal), thermal transfer, high adhesion polyester.
 - 2. Provide UV resistant laminate for outdoor labels.
- H. Arc Flash Label Information:
 - 1. Equipment name.
 - 2. Identifier LINE or LOAD where equipment has potential different energy levels.
 - 3. Arc flash hazard information: arc flash boundary and incident energy in cal/cm².
 - 4. Shock hazard information: limited approach and restricted approach boundaries.
 - 5. Personal Protective Equipment (PPE) requirements.
 - 6. Study Supplier, project number, and date.
- I. Provide arc flash label sample with preliminary report.
- J. Do not be print the labels until equipment is energized and protective devices set according to the approved final protective device coordination study.

2.8 HARMONIC ANALYSIS

- A. Comply with IEEE 519 and IEEE 3002.8.
- B. Provide a harmonic analysis for all major harmonic producing equipment to determine the harmonic currents and voltages of the electrical distribution system. Include utility and alternate power sources, if applicable. Major harmonic producing equipment includes:
- C. Provide a harmonic current and voltage profile for the complete electrical distribution system. At a minimum, the voltage profile shall include voltage values at the utility service point, and at each switchgear/switchboard and motor control center bus.
- D. Provide calculations for all operating modes and the following conditions:
 - 1. One profile for all duty equipment running with variable frequency controllers at full speed.
 - 2. One profile for all duty equipment running with variable frequency controllers at 60 percent speed.
- E. Include in the analysis:
 - 1. Explanation of analysis method.
 - 2. Explanation of analysis and recommendations to meet the specified limits.
 - 3. Calculations and/or computer printouts.
 - 4. Harmonic current and voltage profiles up to the fiftieth harmonic.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
 - 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 - 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate the required input data to support the power system study.
- C. Field data gathering for existing systems shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
- D. Data included, but are not limited to, the following:
 - 1. Product data for overcurrent protective devices and existing settings.

2. Electrical power utility impedance at the service and upstream protective device data.
3. Power sources and ties.
4. For switchgear, switchboards, panelboards, and motor control centers, ampacity and SCCR in amperes RMS symmetrical.
5. For transformers, kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
6. For reactors, manufacturer and model designation, voltage rating, and impedance.
7. For circuit breakers, trip units, and fuses, manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
8. For generators, short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. For busways, manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. For motors, horsepower and NEMA MG 1 code letter designation.
11. Conductor sizes, lengths, number, conductor material, shield parameters for medium voltage cable, and conduit material (magnetic or nonmagnetic).
12. For relays, manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
13. Derating factors.

3.2 FIELD QUALITY CONTROL

- A. Do all testing and adjustment prior to the energization of new equipment.
- B. Test existing adjustable protective devices in accordance with NETA MTS.
- C. Test new adjustable protective devices in accordance with NETA ATS.
- D. Adjust existing and new protective devices according to approved coordination study.
- E. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
- F. After successful testing and adjustment, install calibration sticker with Field Adjusting Agency name, employee initials, and date of calibration at each relay or protective device.
- G. After energization, minor adjustments to settings may be required to commission the equipment.
- H. Submit field report and list any changes made during field adjustment or commissioning for update for record submittal of study.

3.3 ARC FLASH LABELING

- A. After the field adjustment of relays and protective devices, apply arc flash study labels.
- B. Apply arc flash labels on the front covers of the following equipment:
 1. Substations and distribution transformers.

2. Medium voltage switches.
 3. Switchgear, switchboards, and panelboards.
 4. Motor control centers.
 5. Variable frequency controllers.
 6. Disconnect switches.
 7. Transfer switches.
 8. 480V control panels.
- C. Apply arc-flash labels at each section for large equipment such as switchgear and motor control centers.
- D. Install LINE and LOAD arc-flash labels as applicable.
- E. Remove any previous arc flash study labels as applicable and install new labels under the direction of the Power System Analysis Specialist.

END OF SECTION 260573

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SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

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 distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

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 each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for transformers, 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.
 - 4. Certification: Indicate that equipment meets Project seismic requirements.

- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified."

2.3 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- C. Coils: Continuous windings except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Taps for Transformers 3 kVA and Smaller: None.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class, Smaller Than 30 kVA: 180 degrees C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 degrees C ambient temperature.
- I. Insulation Class, 30 kVA and Larger: 220 degrees C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 degrees C ambient temperature.
- J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 degrees C maximum ambient and a 24-hour average ambient of 30 degrees C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
- M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dBA.
 - 2. 9.01 to 30.00 kVA: 45 dBA.
 - 3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
 - 4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.

2.5 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 - 2. Ratio tests at rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation-Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes

applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Secure transformer to concrete base according to manufacturer's written instructions.
- C. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- D. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.

- b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

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SECTION 262300 - LOW-VOLTAGE SWITCHGEAR

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 metal-enclosed, low-voltage switchgear, with drawout power circuit breakers and metering and control accessories.

- 1. Switchgear structure.
- 2. Requirements for indoor switchgear.
- 3. Requirements for outdoor switchgear.
- 4. Circuit breakers.
- 5. Zone-selective interlocking.
- 6. Surge suppression.
- 7. Control power supply, 120-V ac.
- 8. Instrumentation and control.
- 9. Maintenance tools.
- 10. Identification.
- 11. Source quality control.
- 12. Delegated Design.

- B. Related Requirements:

- 1. Section 266100 "Electrical Power House".
- 2.

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 switchgear.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For low-voltage switchgear.

- 1. System Power One-Line Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
 - a. Frame size of each circuit breaker.
 - b. Trip rating for each circuit breaker.
 - c. Conduit and wire size for each feeder.

2. Include BOM, master drawing index, plans, elevations, sections, shipping splits, and mounting details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
5. Indicate short-time and short-circuit current rating of switchgear assembly.
6. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include mimic-bus diagram.

1.4 DELEGATED DESIGN SUBMITTALS

- A. For low-voltage switchgear:
 1. Comply with Section 260573 "Power System Studies."

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around the low-voltage switchgear where pipe and ducts are prohibited.
- B. Qualification Data: For testing agency.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.
 1. Include the following:
 - a. Time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device.
 - b. Lists of spare parts and replacement components recommended for storage at Project site.
 - c. Detailed instructions covering operation under both normal and abnormal conditions.
 - d. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB 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. Fuses: One for every three of each type and rating, but no fewer than three of each for the following:
 - a. Potential transformers.
 - b. Control power circuits.
- B. System Power Riser Diagram: For each switchgear, post on the wall at each location, using non-fugitive ink on high-quality paper.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. When provisions for temporary power connection are provided as part of the switchgear assembly, provisions shall be included to prevent energization of primary buses or connections by means of backfeed through fuses or control power transformers connected to the primary buses or connections.
- B. If outdoor switchgear cannot be installed and energized, temporary power shall be provided for the operation of the space heaters provided so as to prevent condensation of moisture within the housing.
- C. Ventilation openings shall be left open to permit proper air circulation.

1.10 FIELD CONDITIONS

- A. Ambient Environment Ratings:
1. Ambient Temperature Rating: Not less than minus 22 degrees F and not exceeding 104 degrees F.
 2. Humidity Rating: Less than 95 percent (noncondensing).
 3. Altitude Rating: Not exceeding 6600 feet.

4. The effect of solar radiation is insignificant.

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. ABB, Electrification Business.
 2. Eaton.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; Schneider Electric USA.

2.2 SYSTEM DESCRIPTION

- A. Description: Metal-enclosed, low-voltage switchgear with drawout power circuit breakers, with accessories and metering components.
 1. 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. Comply with IEEE C37.20.1.
 3. Listed and labeled as complying with UL 1558.
 4. Listed and labeled for use as service entrance equipment.

2.3 PERFORMANCE AND DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer, as defined in Sections 013300 "Submittal Procedures" and 014000 "Quality Requirements", to submit the items listed in the DELEGATED DESIGN SUBMITTALS Article.
- B. Capacities and Characteristics:
 1. Nominal System Voltage: 480 V, three wire, 60 Hz.
 2. Rated Maximum Voltage: 635 V.
 3. Rated Power Frequency: 60 Hz.
 4. Rated Insulation Level: Power frequency withstand shall be not less than 2.2-kV rms.
 5. Rated Continuous Current:
 - a. Main-Bus Continuous: As shown on the Drawings.
 - b. Vertical Section Bus Riser: Equal to the frame size of the low-voltage power circuit breaker connected to that riser.
 6. Rated Short-Circuit Withstand Current: 65,000 A symmetrical.
 7. Short-Time and Short-Circuit Current: Match rating of integrated short-circuit current rating.

2.4 SWITCHGEAR STRUCTURE

- A. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker. Extend section barriers between main and tie circuit breakers to the rear of the section.
- B. Allow the following circuit-breaker functions to be performed when the compartment door is closed:
 - 1. Operate manual charging system.
 - 2. Open and close the circuit breaker.
 - 3. Examine and adjust the trip unit.
 - 4. Read the breaker nameplate.
- C. Install instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires, and cables.
- D. Switchgear Bus:
 - 1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
 - 2. Main Phase Bus: Uniform capacity the entire length of assembly.
 - 3. Ground Bus: Uniform capacity the entire length of assembly, with pressure connector terminations for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
 - 4. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
 - 5. Bus Material and Connections:
 - a. Phase--Bus Material: Tin-plated copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
 - b. Use copper for connecting circuit-breaker line to copper bus.
 - c. Contact Surfaces of Buses: Tin-plated.
 - d. Feeder Circuit-Breaker Load Terminals: Tin-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
 - 6. Neutral Disconnect Link: Bolted, uninsulated, bus, arranged to connect neutral bus to ground bus.
 - 7. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
- E. Circuit-Breaker Compartment:
 - 1. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
 - a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.



- b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
- c. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from connected, test, and disconnected positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from the structure. When compartment door is open, status for connection devices for different positions includes the following:
 - 1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
 - 2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
- d. Primary Disconnect: Mount on the stationary part of the compartment. Disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the connected position. Assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall connect to bus extensions that terminate in solderless terminals in the rear cable compartment.
- e. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of breaker.
- f. Provide a verification of positive ground contact between the circuit breaker and its compartment when the accessory cover is removed while the circuit breaker is in connected, test, disconnected, and withdrawn positions.
- g. Place 2400-A frame and larger circuit breakers at the bottom of switchgear.

2.5 ADDITIONAL REQUIREMENTS FOR INDOOR SWITCHGEAR

- A. Enclosure Rating: Indoor NEMA 1A; gasketed.
- B. Enclosure Material: Steel.
- C. Enclosure Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
- D. Enclosure Rear Panels: Removable and hinged, to allow access to rear interior of switchgear.

2.6 ADDITIONAL REQUIREMENTS FOR OUTDOOR SWITCHGEAR

- A. Outdoor Enclosure Rating: NEMA 3R.
- B. Outdoor Enclosure Description: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating
- C. Outdoor Enclosure Material: Steel.

- D. Outdoor Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands 120 hours of exposure to salt-spray test specified in ASTM B117, without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be conducted according to ASTM D1654, with a rating of not less than 7 per Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel shall be coated with a manufacturer's standard zinc-rich paint.
- E. Features:
1. Comply with locally adopted codes for gravity and wind loads. Structural design and anchorage adequate to resist loads imposed by 120-mph wind.
 2. Sloping, standing-seam type, insulated roof panels.
 3. Mount each shipping group on an integral base frame as a complete weatherproof unit.
 4. Common Internal Aisle-Type Construction:
 - a. With aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
 - b. Aisle access doors with outside padlocking provisions and interior panic latches.
 - c. Vaporproof LED aisle lights, controlled by wall switch at each entrance.
 - d. GFCI duplex receptacles, a minimum of two, located in aisle.
 - e. Interior Space Conditioning: Aisle ventilation louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.

2.7 CIRCUIT BREAKERS

- A. Drawout type, unfused, power operated, with electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.
- B. Ratings: For continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear. Comply with IEEE C37.16.
1. Circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 A, whether or not equipped with instantaneous trip protection.
- C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
1. Normal Closing Speed: Independent of both control and operator.
 2. Slow Closing Speed: Optional with operator for inspection and adjustment.
 3. Stored-Energy Mechanism: Electrically charged.
 - a. Operating Handle: One for each circuit breaker capable of manual operation.
 - b. Electric Close Button: One for each electrically operated circuit breaker.
 4. Provide an interlock to discharge the stored energy mechanism before the circuit breaker can be withdrawn from its compartment.
 5. Operation counter.

- D. Operator Display: Located on the face of the circuit breaker.
 - 1. Electrical operation buttons to open and close the circuit breaker. Provide a clear lockable cover over the buttons.
 - 2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. An energized or hot condition shall be indicated by a red light. The de-energized, open, and safe condition shall be indicated by a green light.
 - 3. Indicator to show the position of the circuit-breaker contacts, status of the closing springs, and circuit-breaker position in its compartment.
 - 4. Provide a "charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.

- E. Overcurrent Protective Tripping: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
 - 1. Programmable functions independent of each other in both action and adjustment.
 - a. Long-time setting.
 - b. Long-time-delay with selectable I2T or I4T curve shaping.
 - c. Short-time setting.
 - d. Short-time-delay with flat or selectable I2T curve shaping.
 - e. Instantaneous trip.
 - 2. Field-adjustable, time-current characteristics.
 - 3. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
 - 4. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
 - 5. Pickup Points:
 - a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-T operation.
 - b. Five minimum, for instantaneous-trip functions.
 - 6. Arc flash reduction technology: allow a preset maintenance mode with an accelerated instantaneous override trip to reduce arc flash energy.

- F. Ground-Fault Protection:
 - 1. Test Form: Provide each ground-fault relay with information sheets describing system-testing instructions, and with a test form; comply with UL 1558.

- G. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

- H. Metering:
 - 1. Accuracy: 0.5 percent of reading, complying with ANSI C12.20.
 - 2. Values shall be rms average over a period of one second.
 - a. Current: Each phase, and three-phase average.

- b. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
- c. Active Power (kW): Each phase and three-phase total.
- d. Reactive Power (kVAR): Each phase and three-phase total.
- e. Apparent Power (kVA): Each phase and three-phase total.
- f. Power Factor: Each phase and three-phase total.
- g. Active Energy (kWh): Three-phase total.

I. Auxiliary Contacts:

1. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
2. Spare auxiliary switches, at least two, unless otherwise indicated. Each switch shall consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.

2.8 ZONE-SELECTIVE INTERLOCKING

- A. Trip units for indicated circuit breakers shall include zone-interlocking capability for the short-time delay and ground-fault delay trip functions for system coordination and arc energy reduction. Zone-interlocking system shall restrain the tripping of an upstream circuit breaker and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the preset time delay. Zone-interlock system shall be factory wired and tested for circuit breakers within the switchgear.

2.9 SURGE SUPPRESSION

- A. Surge Suppression: Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:
 1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Form-C contacts rated at 5-A 250-V ac, one NO and one NC, for remote monitoring of protection status.
 5. Surge counter.

2.10 CONTROL POWER SUPPLY, 120-V AC

- A. Control Power Transformer: Supply 120-V control circuits through dry-type control power transformers, include secondary disconnect devices.
 1. Place transformers larger than 3 kVA in separate compartments at the bottom of the vertical section, including the related primary and secondary fuses.
 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.

- a. Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
 - b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

2.11 INSTRUMENTATION AND CONTROL

- A. Instrument Transformers: Comply with IEEE C57.13. Instrument transformers may not be used to power space conditioning equipment associated with outdoor switchgear, or for power to convenience receptacles and lighting.
 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Burden and Accuracy class suitable for connected relays, meters, and instruments.
- B. Power Monitoring: Separately mounted, modular, permanently installed, solid-state, digital I/O multifunction metering instrument for power and energy metering and monitoring, complying with UL 61010-1.
 1. Capable of metering four-wire Y, three-wire Y, three-wire delta, and single-phase power systems.
 2. Equipped with security lock to protect revenue-related metering from unauthorized and accidental changes.
 3. Comply with IEC 60529 degree of protection code of IP65 for the front of meter, and code of IP30 for the body.
 4. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
 5. Accuracy:
 - a. Comply with ANSI C12.20, Class 0.5.
 - b. Neutral Current Measurement: Not more than 0.65 percent.
 - c. Power Factor: 1.0 percent.
 - d. Frequency: 0.1 percent.
 - e. THD: 1.0 percent.
 - f. Waveform Sampling: 64 per cycle.
 6. Data Link: Ethernet connectivity specified in this article; TCP/IP protocol.
 7. Meter Physical Characteristics:
 - a. Display: Backlit LCD with antiglare and scratch-resistant lens.
 - b. Display of Metered Values: One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
 - 1) All meters.
 - 2) Measurements.
 - 3) THD.

- 4) Energy.
 - 5) Demand.
 - 6) Minimum and maximum values.
 - 7) Power demand.
8. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.
9. Meters:
 - a. Instantaneous, rms:
 - 1) Current: Each phase, and three-phase average.
 - 2) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - 3) Active Power (kW): Each phase and three-phase total.
 - 4) Reactive Power (kVAr): Each phase and three-phase total.
 - 5) Apparent Power (kVA): Each phase and three-phase total.
 - 6) Power Factor: Each phase and three-phase total.
 - b. Energy:
 - 1) Active Energy (kWh): Three-phase total.
 - c. Demand, Derived from Instantaneous rms Meters:
 - 1) Current: Present and maximum.
 - 2) Active: Present and maximum.
 - 3) Reactive: Present and maximum.
 - 4) Apparent: Present and maximum/
 - d. Power Quality Measurements:
 - 1) THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
10. I/O: Two optically isolated digital outputs for KYZ pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
 - a. KYZ Pulse: Generate standard KYZ pulses for a user-defined increment of metered active energy as follows:
 - 1) User-defined pulse output, associated with kWh.
 - 2) User-defined pulse output, associated with kVArh.
11. Capacities and Characteristics:
 - a. Circuit Connections:

- 1) Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect to instrument-grade potential transformers secondary at 120 V. Meter impedance shall be 2 Mohms L-L or greater.
- 2) Overload Tolerance: 1500-V ac, rms, continuously.
- 3) Current: Connect to instrument-grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
- 4) Frequency: 45 to 65 Hz.
- 5) Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.12 POWER TRANSFER CONFIGURATIONS

- A. Factory-installed and -tested controls of circuit breakers to accomplish automatic transfer controls for switchgear having two power sources.
- B. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
- C. Control Wiring:
 1. Factory installed, complete with bundling, lacing, and protection.
 2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 3. Install plugs in control wiring at shipping splits.
- D. Two-Breaker Transfer Control:
 1. Two-breaker transfer control shall provide for a switchgear assembly with a common load bus and one normally energized low-voltage power source and one low-voltage legally-required standby generator source, designated "normal" and "standby," connected to the load bus. Circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage sensing transformers.
 2. In automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
 3. Sequence of Operation:
 - a. Default operation shall be with the normal source main breaker closed and the standby main breaker open. On detection of an undervoltage to the line side of the normal main breaker and after a field-adjustable time delay, that main breaker shall open and after an additional field-adjustable time delay, the standby breaker shall close restoring power to the facility.
 - b. On restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker shall open and after a field-adjustable time delay, the normal main breaker shall close.
 4. Field-Adjustable Transfer Parameters:

- a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
 - b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range: zero seconds to 120 seconds.
 - c. Delay the transfer from the standby power source to the normal power source. Delay range: zero seconds to 30 minutes.
 - d. A relay with contact that changes state when the power is available on the normal source and a relay with contact that changes state when the power is available on the standby source.
 - e. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to standby power source regardless of condition of normal source. Pilot light indicated override status.
5. Controls and Indicators: Besides the delay setting controls, provide the following:
- a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers are tripped due to overcurrent or ground fault.
 - b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
 - c. Transfer-control automatic and manual selector.
 - 1) Interlock shall prevent paralleling of the two power sources in manual mode.
 - d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
 - e. Selector to place control into programming mode.
 - f. Circuit-breaker control switch for each of the normal and standby source breakers, providing open and close operation.
 - g. Push button to initiate manual retransfer to the normal source when the transfer controller is in automatic mode.
 - h. Meters and display to show the following:
 - 1) Voltage and frequency of both sources.
 - 2) A multiline display showing the following:
 - a) Set points of timers, and voltage pickup and dropout set points.
 - b) Date, time, and reason for at least the last 10 transfers. Display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
 - c) When the control system is in the transferring process, display shall show delay countdown in seconds.
 - i. LED indicator lights to show the following:
 - 1) Normal source available.
 - 2) Standby source available.
 - 3) Normal source connected.

- 4) Standby source connected.
 - 5) Load bus energized.
6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
 7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.13 MAINTENANCE TOOLS

- A. Description: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
- B. Include the following:
 1. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
 2. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
 3. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
 4. Racking handle to move circuit breaker manually between connected and disconnected positions.
- C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
- D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.14 IDENTIFICATION

- A. Compartment Nameplates: Engraved, laminated-acrylic, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. For Outdoor Switchgear SWGR-1: Provide permanent sign as follow:
 1. "MAIN DISCONNECT LOCATED INSIDE" on all enclosure doors.
- C. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
 1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 2. Medium: Painted graphics, as selected by Engineer.
 3. Color: Contrasting with factory-finish background; as selected by Engineer from manufacturer's full range.

D. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
 - a. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1) Location designation.
 - 2) Nominal voltage.
 - 3) Flash protection boundary.
 - 4) Hazard risk category.
 - 5) Incident energy.
 - 6) Working distance.
 - 7) Engineering report number, revision number, and issue date.
 - b. Labels shall be machine printed, with no field-applied markings.

2.15 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect low-voltage switchgear according to IEEE C37.20.1. Drawout circuit breakers need not be tested in the assembly if they are tested separately.
 1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate the ability of the insulation system to withstand the voltages listed in IEEE C37.20.1. The voltage is to be increased gradually from zero to the required test value within 5 to 10 seconds and shall be held at that value for one minute.
 2. Perform mechanical operation tests to ensure proper functioning of operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
 3. Test the effectiveness of grounding of each metal-case instrument transformer frame or case.
 4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in the intended sequence.
 5. Perform the control wiring insulation tests.
 6. Verify correct polarity of the connections between instrument transformers and meters and relays.
- B. All serial communications devices within the equipment shall be addressed at the factory and tested to verify reliable communications to the equipment's Ethernet gateway.
- C. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Owner will witness required factory tests. Notify Engineer at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross the section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.
- D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be five ohms at the switchgear location.
- E. On delivery of switchgear and prior to unloading, inspect equipment for damage.
 - 1. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing are tight.
 - 2. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's written instructions.
 - 3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
 - 4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories comply with manufacturer's written instructions and Shop Drawings. If the shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
 - 5. Unload switchgear, observing packing label warnings and handling instructions.
 - 6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- F. Handling:
 - 1. Handle switchgear, according to manufacturer's written instructions; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
 - 2. Protect switchgear compartments against the entrance of dust, rain, and snow.
 - 3. Transport switchgear upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
 - 4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
 - 5. Do not damage structure when handling switchgear.

- G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Grounding Connections at Exterior Locations:
 - 1. Install tinned bare copper conductors not smaller than No. 4/0 AWG, for ground conductors buried not less than 30 inches below grade interconnecting the grounding electrodes.
 - 2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as indicated.
 - 3. Keep lead lengths as short as practicable with no kinks or sharp bends.
 - 4. Make joints in grounding conductors and loops by exothermic weld or compression connector.
- C. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.
- D. Complete switchgear grounding and surge-protector connections prior to making any other electrical connections.

3.4 IDENTIFICATION

- A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
- B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:

1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter and of NETA ATS.
2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Visual and Mechanical Inspection:
 - a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study.
 - b. Verify that current and voltage transformer ratios correspond to Drawings.
 - c. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 2) Make key exchange with devices operated in off-normal positions.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - g. Verify correct barrier and shutter installation and operation.
 - h. Exercise active components.
 - i. Inspect mechanical indicating devices for correct operation.
 - j. Verify that filters are in place and that vents are clear.
 - k. Perform visual and mechanical inspection of instrument transformers according to "Instrument Transformer Field Tests" Paragraph.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
5. Electrical Tests:

- a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the bus temperature is other than plus or minus 20 degrees C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
 - 1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
 - 2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
- b. Perform a dielectric withstand voltage test on each bus section, phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
 - 1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
- c. Perform insulation-resistance tests on control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's written instruction.
 - 1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.
- d. Control Power Transformers:
 - 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Insulation-resistance values of winding insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
 - 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
 - 3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 - 4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.
- e. Voltage Transformers:

- 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
 - 2) Verify secondary voltages by energizing the primary winding with system voltage.
- f. Perform current-injection tests on the entire current circuit in each section of switchgear.
- 1) Perform current tests by secondary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
 - 2) Perform current tests by primary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
- g. Perform system function tests according to "System Function Tests" Article.
- h. Verify operation of space heaters.
- i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

C. Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that all maintenance devices are available for servicing and operating the breaker.
- d. Verify the unit is clean.
- e. Verify that the arc chutes are intact.
- f. Inspect moving and stationary contacts for condition and alignment.
- g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
- i. Verify cell fit and element alignment.
- j. Verify racking mechanism operation.
- k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- l. Perform adjustments for final protective-device settings according to coordination study provided by Owner.
- m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

- a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation

resistance less than Table 100.1 or manufacturer's written instructions shall be investigated.

- b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
- d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
- g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
- h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
- i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
- k. Verify operation of charging mechanism. Charging mechanism shall operate according to manufacturer's published data.

D. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data complies with the Contract Documents.
- b. Inspect physical and mechanical condition.
- c. Verify correct connection of transformers with system requirements.
- d. Verify that adequate clearances exist between primary and secondary circuit wiring.
- e. Verify that the unit is clean.
- f. Inspect bolted electrical connections for high resistance using one of the following two methods:

- 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- g. Verify that required grounding and shorting connections provide contact.
 - h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - i. Verify correct primary and secondary fuse sizes for voltage transformers.
 - j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests of Current Transformers:
- a. Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
 - b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
 - c. Perform a ratio-verification test using the voltage or current method according to IEEE C57.13.1. Ratio errors shall be according to IEEE C57.13.
 - d. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by manufacturer or be according to IEEE C57.13.1.
 - e. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
 - f. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.5.
 - g. Perform dielectric withstand tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.9.
 - h. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
 - i. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by Engineer in Project Drawings.
3. Electrical Tests of Voltage Transformers:
- a. Perform insulation-resistance tests, winding-to-winding and winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values

of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.

- b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.
- c. Perform a turns-ratio test on all tap positions. Ratio errors shall be according to IEEE C57.13.
- d. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
- e. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. Dielectric voltage shall be according to NETA ATS, Table 100.9. Test voltage shall be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.
- f. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
- g. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

E. Ground-Resistance Test:

1. Visual and Mechanical Inspection:

- a. Verify that ground system complies with the Contract Documents and with NFPA 70, Article 250, "Grounding and Bonding."
- b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
- c. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- d. Inspect anchorage.

2. Electrical Tests:

- a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. Resistance between the main grounding electrode and ground shall be no more than 5 ohms.

- b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with the Contract Documents.
- c. Inspect physical and mechanical condition.
- d. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

F. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
- d. Verify that the unit is clean.
- e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

- a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
- b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
- c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.

- d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

G. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

- a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
- b. Verify operation of LEDs, display, and targets.
- c. Record passwords for each access level.
- d. Clean the front panel and remove foreign material from the case.
- e. Check tightness of connections.
- f. Verify that the frame is grounded according to manufacturer's written instructions.
- g. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

- a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
- b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
- c. Check functional operation of each element used in the protection scheme as follows:
 - 1) ANSI No. 2/62, Timing Relay:
 - a) Determine time delay.
 - b) Verify operation of instantaneous contacts.
 - 2) ANSI No. 24, Volts/Hertz Relay:
 - a) Determine pickup frequency at rated voltage.
 - b) Determine pickup frequency at a second voltage level.
 - c) Determine time delay.
 - 3) ANSI No. 25, Sync Check Relay:
 - a) Determine closing zone at rated voltage.
 - b) Determine maximum voltage differential that permits closing at zero degrees.
 - c) Determine set points of live line, live bus, dead line, and dead bus.
 - d) Determine time delay.
 - e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.
 - 4) ANSI No. 27, Undervoltage Relay:
 - a) Determine dropout voltage.

- b) Determine time delay.
 - c) Determine time delay at a second point on the timing curve for inverse time relays.
- 5) ANSI No. 32, Directional Power Relay:
- a) Determine minimum pickup at maximum torque angle.
 - b) Determine closing zone.
 - c) Determine maximum torque angle.
 - d) Determine time delay.
 - e) Verify time delay at a second point on the timing curve for inverse time relays.
- 6) ANSI No. 46, Current Balance Relay:
- a) Determine pickup of each unit.
 - b) Determine percent slope.
 - c) Determine time delay.
- 7) ANSI No. 46N, Negative Sequence Current Relay:
- a) Determine negative sequence alarm level.
 - b) Determine negative sequence minimum trip level.
 - c) Determine maximum time delay.
 - d) Verify two points on the I-two-squared-T curve.
- 8) ANSI No. 47, Phase Sequence or Phase Balance Voltage Relay:
- a) Determine positive sequence voltage to close the NO contact.
 - b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
 - c) Verify negative sequence trip.
 - d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
 - e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.
- 9) ANSI No. 50, Instantaneous Overcurrent Relay:
- a) Determine pickup.
 - b) Determine dropout.
 - c) Determine time delay.
- 10) ANSI No. 51, Time Overcurrent:
- a) Determine minimum pickup.
 - b) Determine time delay at two points on the time current curve.
- 11) ANSI No. 64, Ground Detector Relay:
- a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, Directional Overcurrent Relay:

- a) Determine directional unit minimum pickup at maximum torque angle.
- b) Determine closing zone.
- c) Determine maximum torque angle.
- d) Plot operating characteristics.
- e) Determine overcurrent unit pickup.
- f) Determine overcurrent unit time delay at two points on the time current curve.

13) ANSI No. 87, Differential Relay:

- a) Determine operating unit pickup.
- b) Determine the operation of each restraint unit.
- c) Determine slope.
- d) Determine harmonic restraint.
- e) Determine instantaneous pickup.
- f) Plot operating characteristics for each restraint.

d. Control Verification:

1) Functional Tests:

- a) Check operation of all active digital inputs.
- b) Check output contacts or SCRs, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
- c) Check internal logic functions used in protection scheme.
- d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

H. Ground-Fault Protection Field Tests: Evaluate the interconnected system according to switchgear manufacturer's written instructions.

1. Determine the proper location of the sensors around the bus of the circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
2. Verify the grounding points of the system to determine that ground paths do not exist that would bypass the sensors. Use high-voltage testers and resistance bridges.
3. Test the installed system for correct response by application of full-scale current into the equipment to duplicate a ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:
 - a. A coil around the sensors.
 - b. A separate test winding in the sensors.
4. Record the test results on the test form provided with the instructions provided by manufacturer.

- I. Switchgear components will be considered defective if they do not pass tests and inspections.
- J. Remove and replace defective units and retest.
- K. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.6 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
 - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Switchgear will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, and if requested by Owner, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each piece of switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust switchgear taps.
 - b. Prepare written request for voltage adjustment by electric utility.
 - 3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
 - 4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 degree C at 30 degrees C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and that lists the results as follows:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of the deficient area.
4. Act on inspection results according to recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. 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 and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 262300

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SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 degrees F (minus 5 degrees C) to plus 104 degrees F (plus 40 degrees C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. 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.

- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
 - 2. Height: 84 inches (2.13 m) maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- F. Incoming Mains:
 - 1. Location: Bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material as indicated on the Drawings. Locate at opposite end of bus from incoming lugs or main device.
- I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 5 percent.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

- 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. ABB, Electrification Business.
 2. Eaton.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; Schneider Electric USA.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 ELECTRONIC-GRADE PANELBOARDS

- 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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.
 - 1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V; 1200 V for 208Y/120 V.
3. SCCR: Equal to the SCCR of the panelboard in which installed.
4. Inominal Rating: 20 kA.

G. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.

- 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.7 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Install panelboards 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. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- I. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- J. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- K. Install filler plates in unused spaces.
- L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- M. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
- c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Engineer. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

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SECTION 262419 - MOTOR CONTROL CENTERS

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 MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components for San Gabriel WWTP:
 - 1. Active harmonic filter and power correction unit.
 - 2. Variable frequency drives.
 - 3. Solid-state reduced voltage starters.
 - 4. Auxiliary devices.
 - 5. Panelboards.
 - 6. Transformers.
- B. Related Requirements
 - 1. Section 260573 "Power System Studies" for arc-flash analysis and arc-flash label requirements.
 - 2. Section 266100 "Electrical Power House" for pre-fabricated electrical walk-in enclosure requirements.
 - 3. Section 262923 "Variable-Frequency Motor Controllers" for variable frequency drive requirements.
 - 4. Section 263533 "Power Correction Equipment" for active harmonic filter and power factor correction unit requirements.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. AHF: Active harmonic filter.
- C. MCC: Motor-control center.
- D. MCCB: Molded-case circuit breaker.
- E. MCP: Motor-circuit protector.
- F. OCPD: Overcurrent protective device.
- G. PCU: Power correction unit. Used interchangeably with AHF.

- H. PID: Control action; proportional plus integral plus derivative.
- I. PT: Potential transformer.
- J. SPD: Surge protective device.
- K. SCR: Silicon-controlled rectifier.
- L. VFD: Variable-frequency drive.
- M. 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.

1.4 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 MCCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.
 - 3. Provide AHF sizing calculations to confirm required harmonic mitigation and power factor correction performance for the AHF's proposed.
 - 4. AHF assembly rated input KVA and output KVA, topology, converter/inverter type, percent efficiency, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
 - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
 - g. Specified optional features and accessories.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
 - 3. Nameplate legends.
 - 4. Vertical and horizontal bus capacities.
 - 5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 INFORMATIONAL SUBMITTALS

- A. Production Drawings: For each MCC, as defined in UL 845.
- B. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- C. Qualification Data: For testing agency.
- D. Product Certificates: For each MCC.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- I. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For MCCs, all installed devices, 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:
 - 2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
 - 3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 4. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
 - 6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.
- D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handle MCCs according to the following:
 - 1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
 - 2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
- B. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC and SPD that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.

2.2 SYSTEM DESCRIPTION

- A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.
- B. Ambient Environment Ratings:
 - 1. Ambient Temperature Rating: Not less than 0 degrees F and not exceeding 104 degrees F, with an average value not exceeding 95 degrees F over a 24-hour period.
 - 2. Ambient Storage Temperature Rating: Not less than minus 4 degrees F and not exceeding 140 degrees F
 - 3. Humidity Rating: Less than 95 percent (noncondensing).
 - 4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
- C. 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.

2.3 PERFORMANCE REQUIREMENTS

2.4 MOTOR CONTROL CENTER ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1A gasketed unless otherwise indicated to comply with environmental conditions at installed location.
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

2.5 ASSEMBLY

- A. Structure:
 - 1. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

2. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
- B. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners.
1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
 2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
 3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- C. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- D. Wiring Spaces:
1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
 2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.
- E. Provisions for Future:
1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
 2. Compartments marked "spare" shall include provisions for connection to the vertical bus.
- F. Integrated Short-Circuit Rating:
1. Short-Circuit Current Rating for Each Unit: Fully rated; 65 kA.
 2. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 65 kA.
- G. Control Power:
1. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
- H. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class: NEMA ICS 18, Class II, Type B, for starters larger than Size 3, and Type B-D, for starters Size 3 and smaller.
2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

I. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase-Bus Material: Tin-plated copper of 98 percent minimum conductivity, with mechanical connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.
5. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
 - a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
 - b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
 - c. Time-current adjustments to achieve protective-device coordination as follows:
 - 1) Adjustable long-time delay.
 - 2) Adjustable short-time setting and delay to shape the time-current curve.
 - 3) Adjustable instantaneous setting.
 - 4) Individually adjustable ground-fault setting and time delay.
 - d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker. Provide one test set for testing the installed circuit breakers 225-A frame and higher.
 - e. Built-in digital ammeter display, showing load current and tripping cause.
3. Switch operator power shall be from control power specified in "Assembly" Article.

- B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2.

2.7 MAGNETIC CONTROLLERS

- A. Controller Units: Combination controllers.
- B. Disconnects:
 - 1. MCP:
 - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
 - 2. MCCB:
 - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
- C. Controllers: Comply with UL 508.
 - 1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
 - a. Classification: Nonreversing.
- D. Overload Relays:
 - 1. Solid-State Overload Relays:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 2. NC isolated overload alarm contact.
 - 3. External overload reset push button.

2.8 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

- A. Controller Units: An integrated unit with disconnects, power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays. Comply with UL 508.

1. Suitable for use with NEMA MG 1 Design B, polyphase induction motors.
- B. Disconnects:
 1. MCP:
 - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. NC alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
- C. Configuration: Standard duty; nonreversible.
- D. Starting Mode: Voltage ramping Current limit; field selectable.
- E. Stopping Mode: Coast to stop; field selectable.
- F. Bypass Contactor: Shall operate automatically to bypass the SCRs when the motor has reached rated speed and full voltage is applied to motor. Solid-state controller protective features shall remain active when the bypass relay is in the bypass mode.
 1. Bypass Contactor: Manufacturer's standard product.
 2. Bypass Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.
- G. Acceleration Control: Adjustable, using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
- H. SCR Bridge: At least two SCRs per phase, for stable and smooth acceleration with external feedback from the motor or driven equipment.
- I. Keypad: Front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
 1. Adjusting motor full-load amperes, as a percentage of the controller's rating.
 2. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
 3. Adjusting linear acceleration and deceleration ramps, in seconds.
 4. Setting initial torque, as a percentage of the nominal motor torque.
 5. Adjusting torque limit, as a percentage of the nominal motor torque.
 6. Adjusting maximum start time, in seconds.
 7. Adjusting voltage boost, as a percentage of the nominal supply voltage.
 8. Selecting stopping mode and adjusting parameters.
 9. Selecting motor thermal-overload protection class between 5 and 30.
 10. Activating and deactivating protection modes.
 11. Selecting or activating communications modes.

- J. Digital Display: Front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
1. Controller Condition: Ready, starting, running, stopping.
 2. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
 3. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
- K. Controller Diagnostics and Protection:
1. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
 2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency excursions to over- or under-normal. Accomplish protection by the following:
 - a. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
 - b. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
- L. Remote Output Features:
1. All outputs prewired to terminal blocks.
 - 2.
 3. Form C status contacts that change state when controller is running.
 4. Form C alarm contacts that change state when a fault condition occurs.
- M. Overload Relays:
1. Solid-State Overload Relays:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. UL 1053, Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- N. Optional Features:
1. Output Signal Interface: A minimum of two programmable analog output signal(s) for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc, which can be configured for any of the following:
 - a. Output current (load)
 - b. Power (kW)
 - c. Power Consumption (kWh)
 - d. Power factor, .



1. Output Signal Interface: A minimum of two programmable analog output signal(s) for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc, which can be configured for any of the following:
 - a. Output current (load)
 - b. Power (kW)
 - c. Power Consumption (kWh)
 - d. Power factor, .
2. Two additional field-assignable Form C contacts for alarm outputs.
3. Full-voltage/BYPASS selector switch. Power contacts shall be totally enclosed, double break, made of silver-cadmium oxide, and assembled to allow inspection and replacement without disturbing line or load wiring.
4. Output Ethernet Interface: Provide EtherNet/IP communication module integral to MCC where indicated on the Drawings. Output monitoring functions including power, power factor, phase current and phase voltage.

2.9 VFC

- A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and.
 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- B. Disconnects:
 1. MCCB:
 - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
 2. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 3. Auxiliary Contacts: NC, arranged to activate before switch blades open.
 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
- C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Overload Capability:
 - a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 - b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
8. Speed Regulation: Plus or minus 5 percent.
9. Output Carrier Frequency: Field selectable.
10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
11. Internal Adjustability Capabilities:
 - a. Minimum Speed: 5 to 25 percent of maximum rpm.
 - b. Maximum Speed: 80 to 100 percent of maximum rpm.
 - c. Acceleration: 0.1 to 999.9 seconds.
 - d. Deceleration: 0.1 to 999.9 seconds.
 - e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
12. Self-Protection and Reliability Features:
 - a. Input transient protection by means of SPDs for three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 - c. Under- and overvoltage trips.
 - d. Inverter overcurrent trips.
 - e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
 - f. Critical frequency rejection, with three selectable, adjustable deadbands.
 - g. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - h. Loss-of-phase protection.
 - i. Reverse-phase protection.
 - j. Short-circuit protection.
 - k. Motor overtemperature fault.
13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
14. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:

1. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:

1. Historical Logging Information and Displays:
 - a. Real-time clock with current time and date.
 - b. Running log of total power versus time.
 - c. Total run time.
 - d. Fault log, maintaining last four faults with time and date stamp for each.
2. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including the following:
 - a. Output frequency (Hz).
 - b. Motor speed (rpm).
 - c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor torque (percentage).
 - f. Fault or alarming status (code).
 - g. PID feedback signal (percentage).
 - h. DC-link voltage (V dc).
 - i. Set-point frequency (Hz).
 - j. Motor output voltage (V ac).

- F. Communication Port: Ethernet or equivalent connection Capable of connecting a printer and a notebook computer.

2.10 CONTROLLER-MOUNTED AUXILIARY DEVICES

- A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil-tight type.
 - a. Push Buttons: Unguarded types; momentary contact unless otherwise indicated.
 - b. Pilot Lights: LED types; push to test.

- c. Selector Switches: Rotary type.
- B. Elapsed-Time Meters: Heavy duty with digital readout in hours; non-resettable.
- C. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.
- D. Auxiliary Dry Contacts: Reversible NC/NO.
- E. Control Relays:
 - 1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
 - 2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.

2.11 MEASUREMENT AND CONTROL DEVICES

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. PTs: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Listed or recognized by a nationally recognized testing laboratory.
 - 2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - 3. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
 - e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

4. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
 5. Data Link: Ethernet connectivity; TCP/IP protocol.
- C. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.



D. RTD Module :

1. Programmable RTD module: Module capable of monitoring up to 12 three wire shielded RTDs, Multilin RRTD, or equal installed integral to MCC.
2. Over-temperature protection: provide configurable RTD inputs, including alarm and trip settings, and associated TRIP or ALARM outputs. Provide the following functionality:
 - a. PTC or NTC Thermistor input.
 - b. Assign RTD inputs as “Off”, “Stator” or “Bearing” type.
 - c. Four different RTD types: 100 Ohm Platinum, 120 Ohm Nickel, 100 Ohm Nickel, or 10 Ohm Copper.
 - d. RTD sensor fail alarm.
3. Provide monitoring functions:
 - a. Temperature of each RTD input.
 - b. Latest trip report containing RTD temperatures.
4. User interface
 - a. Accept AC control power as determined by MCC manufacturer.
 - b. Form C contacts that change state when an over-temperature condition occurs

2.12 FEEDER TAP UNITS

- A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.

3. With built-in digital ammeter and a digital display, showing tripping cause.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.13 PANELBOARDS

- A. Comply with NEMA PB 1.
- B. Branch OCPDs for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in or Bolt-on circuit breakers.
- C. Branch OCPDs for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- D. Accessory Control Power Voltage: Integrally mounted, self-powered,.

2.14 TRANSFORMERS

- A. Factory-assembled and -tested, air-cooled, two-winding, low-voltage dry-type transformers; with primary circuit breaker. Comply with NEMA ST 20.
- B. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- C. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 degrees C rise above 40 degrees C ambient temperature.
- D. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.

2.15 SOURCE QUALITY CONTROL

- A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.
- B. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
 1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- C. MCCs will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive MCCs, 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 INSTALLATION

- A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.
- B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. 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.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in control circuits if not factory installed.
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components.
 - 2. Install required warning signs.
 - 3. Label MCC and each cubicle with engraved nameplate.
 - 4. Label each enclosure-mounted control and pilot device.

5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

D. MCCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

- E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION 262419

SECTION 262505 – 480V CONTROL PANELS

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 industrial control panels with the following features:
 - 1. Enclosure.
 - 2. Main circuit breaker.
 - 3. Motor controllers.
 - 4. Control and monitoring devices.
 - 5. Accessories.
 - 6. Identification.
- B. Related Requirements:
 - 1. Division 26 for electrical work
 - 2. Section 262923 – Variable-Frequency Drives for variable-frequency drive requirements.
 - 3. Division 27 for communications wiring
 - 4. Division 40 for process automation requirements

1.3 DEFINITIONS

- A. CPT: Control power transformer
- B. GFCI: Ground-fault circuit interrupter
- C. MCCB: Molded-case circuit breaker
- D. MCP: Motor circuit protector
- E. NEC: National Electrical Code
- F. RVSS: Reduced voltage soft start
- G. RVAT: Reduced voltage autotransformer start
- H. SCCR: Short-circuit current rating
- I. SPD: Surge protective device
- J. UL: Underwriter’s Laboratories

- K. VFC: Variable frequency motor controller. See VFD
- L. VFD: Variable frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

- A. Product Data: For each control panel.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each control panel.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Bill of materials with part numbers, cross-referenced to plans.
 - 3. Nameplate schedule.
 - 4. Conduit entrance locations and mounting details.
 - 5. Power and control schematics.
 - 6. Certification for compliance with UL 508A.
 - 7. Identification per NEC 409.110.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, from manufacturer.
- B. Startup reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include the following if applicable:
 - 1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - 5. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
 - 6. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

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. Control fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than two of each size and type.
 - 2. Power fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than three of each size and type.
 - 3. Corrosion Inhibitor: Equal to 100 percent of total number of control panels. (One spare per panel.)

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store control panels indoors in clean, dry space with uniform temperature to prevent condensation. Protect control panels from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace control panels that fail in materials or workmanship within specified warranty period.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 - 1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for control panels clearances between control panels and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. 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.
- C. Comply with NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. Comply with NEMA ICS 6: Industrial Control and Systems: Enclosures.
- E. Comply with UL 1203 for control panels located in hazardous (classified) locations.
- F. Comply with NFPA 70.
- G. Comply with UL 508A.
- H. Complete and fully functional control to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. Include manufacturer's recommended safety devices to protect operators. All control devices, unless specified otherwise, mounted in the Control Panel.
- I. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 hertz unless otherwise noted.
- J. Control panel consists of a main circuit breaker, motor circuit protector (MCP) and motor controller for each motor, and a 120-volt control power transformer (fused on primary and secondary) along with other devices specified. Mount all control components in one common enclosure.
- K. Operation of motors will be manually or automatically. Stager control of multiple motors to prevent simultaneous motor starting.
- L. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 40.
- M. Control panels containing PLC's shall contain UPS or battery ride-through for the PLC in accordance with Division 40 specifications.
- N. SCCR: Control panels with main breakers of 125 amps or less shall have SCCR of 35kA, unless specifically noted elsewhere.

2.2 ENCLOSURES

- A. Indoor Enclosures: Surface-mounted, steel cabinets unless otherwise indicated. NEMA 250, Type 1A gasketed unless otherwise indicated to comply with environmental conditions at installed location.

- B. Enclosures: Surface-mounted, dead-front cabinets rated for environmental conditions at installed location. Unless noted elsewhere, NEMA rating shall be NEMA 4X, Type 316 stainless steel, minimum 14 gauge.
- C. Construction: The door shall be mounted via continuous stainless steel hinged and provided with a pad-lockable vault type 3-point latch. The enclosure shall be equipped with a door and shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision.
- D. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.
- E. Operating handle for main circuit breaker: flange mounted.
- F. Outdoor enclosures shall be provided with sun shields. Install sun shields on fronts, sides, and tops of enclosures subject to direct and extended sun exposure.
- G. Provide additional temperature control if required to meet UL temperature rating of internal components. If forced air ventilation is required, the enclosure shall be pressurized. Air filters shall be of commercially available types and sizes.
- H. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.
- I. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment.

2.3 COMPONENTS

- A. Main Breaker: Thermal-magnetic air circuit breaker, Schneider Electric/Square D PowerPact Type BG (125 amp frame, 35kAIC) or equal.
- B. MCP: Molded case motor circuit protector with adjustable magnetic trip only, Schneider Electric/Square D “Mag-Gard” or equal.
- C. Motor Controller:
 - 1. Full Voltage Motor Starting: Open frame, across-the-line, NEMA-rated magnetic motor starter, Schneider Electric/Square D Class 8536 or equal. Solid state overloads with Class 10/20 selectable tripping. Submersible motors shall use Class 10 trip curve.
 - 2. Reduced voltage motor starting: VFD.
- D. Overload relays shall be self-powered solid-state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.

- E. Overload reset buttons shall be mounted on dead front door.
- F. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.
- G. SPD: The control panel shall be provided with a surge protective device (SPD) rated for 100kA per mode for the incoming power. SPD shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker.
- H. Control Power Transformer: 480-120V CPT, fused on primary and secondary sides, capacity as required.

2.4 CONTROL DEVICES AND ACCESSORIES

A. Control Operators and Indicators:

- 1. Heavy duty type, full size (30.5mm), NEMA 4X or 7 as required.
- 2. Each motor shall include Hand-Off-Auto selector switches to permit override of automatic control and manual actuation of shutdown.

B. Indicating Lights:

- 1. LED, full size (30.5mm), full voltage and push-to-test type.
- 2. Indicators shall be provided for individual motor run and an indicator for each failure condition.

C. Elapsed Time Meters (ETM):

- 1. Six (6) digit, non-reset elapsed time meter to indicate the total running time of each motor in "hours" and "tenth of hours". Series T50 as manufactured by the ENM Company or equal.
- 2. Provide an ETM for each motor.

D. Failure Alarm Horn and Beacon Light:

- 1. Alarm horn: weatherproof rated with gasket (Federal Signal Corporation, Cat. #350 or equal) for NEMA 4X applications.
- 2. Alarm beacon: Red lens and solid-state flasher (Ingam Products Inc. LRX-40 or equal) for NEMA 4X applications.
- 3. All lift station pump control panels shall include alarm horn and light for summary alarm condition.
- 4. Silence and reset pushbuttons shall also be furnished. A common failure reset pushbutton shall be provided to reset the alarm conditions (reset shall occur only if fault condition has been cleared).

E. Relays:

- 1. Control relays shall be 10 amp rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status, relays shall be manufactured by Potter Brumfield or equal.

2. Timing relays shall be solid state, with pin (octal) and bases, relays shall be T-series as manufactured by Diversified Electronics Inc. or equal.
 3. Intrinsically safe relays shall be solid state type with 5 amp output contacts, suitable for use on 120 volt, 60 hertz power supply and shall be Factory Mutual approved for devices in Class 1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.
- F. A duplex GFCI utility receptacle (circuit breaker protected) providing 120 volts, 60 Hertz, single phase current shall be mounted on the side of the enclosure.
 - G. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 40, 26 and as shown on the Drawings.
 - H. Alternators shall be provided to sequence lead/lag motors, alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con, or equal.
 - I. A phase monitor shall be provided for the control panel, monitors shall be model SUA-440-ASA as manufactured by Diversified Electronics Inc., or equal.
 - J. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter, selected by the manufacturer, to protect internal components of control panel from corrosion for up to one year.
 - K. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.5 WIRING

- A. Power and control wire shall be 600 Volt class, Type MTW insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.
- B. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.
- C. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.
- D. Terminal blocks shall be 600 Volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal.
- E. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
- F. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 40.
- G. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure

shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.

2.6 IDENTIFICATION

- A. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.
- B. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.
- C. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved black letters with a white background.
- D. All control panels shall be provided with two nameplates located on the exterior door. The first nameplate shall identify the control panel name. The second nameplate shall identify the power source.
- E. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.
- F. Each terminal at terminal blocks shall be individually labeled.
- G. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

System	Wire	Color
Incoming line voltage	Phase conductors	Black
	Ground	Green
	Neutral (as required)	Gray
Internal control voltage	AC	Red
Internal control voltage	DC	Blue
External source	All	Yellow

2.7 FACTORY TESTS

- A. Inspect and test control panel for correct operation. Test each circuit for continuity, short circuits, and ground faults.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Inspect anchorage, alignment, grounding, and clearances.
- C. Compare equipment nameplate data for compliance with Drawings and Specifications.
- D. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- E. Motor Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.
- F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Verify motor running protection is appropriate for actual motors installed.
- C. Test control panel with all field wiring connected. Set adjustable set points and time delays for proper operation of equipment. Adjust as required.
- D. Perform infrared inspection of panel interior during periods of maximum possible loading. Remove all necessary covers prior to the inspection. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
- E. Prepare test and inspection reports.
- F. Install a set of legible "as built" control panel drawings (11x17 or 8.5 x 11), in the storage pocket.

3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment.

END OF SECTION 2625050

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SECTION 262726 - WIRING DEVICES

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. Heavy duty Specification-grade receptacles, 125 V, 20 A.
 - 2. GFCI receptacles, 125 V, 20 A.
 - 3. Hazardous (classified) location receptacles.
 - 4. Cord and plug sets.
 - 5. Toggle switches, 120/277 V, 20 A.
 - 6. Wall plates.

1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- F. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
- G. Wall Plate Color: For plastic covers, match device color.
- H. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 HEAVY DUTY SPECIFICATION-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 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. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two-pole, three-wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

2.3 HEAVY DUTY GFCI RECEPTACLES, 125 V, 20 A

A. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 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. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Type: Feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Hazardous (Classified) Locations Receptacles:

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. Eaton (Arrow Hart).
 - b. EGS/Appleton Electric.
 - c. Killark.
2. Description: Pin and sleeve receptacle with matching connector.
3. Class I.
 - a. Division: 2.
4. Raintight.
5. Voltage: 120 V ac.
6. Hertz: 60 Hz.
7. Amperage: 20 A.
8. Wires and Poles: Three wire, two pole.
9. Standards: Comply with NEMA FB 11, 7CD, 9EFG, and UL 1203.

2.5 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.6 HEAVY-DUTY SPECIFICATION GRADE TOGGLE SWITCHES, 120/277 V, 20 A

- A. Three-Way Switches, 120/277 V, 20 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. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Comply with UL 20 and FS W-S-896.

2.7 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.05-inch- thick, anodized aluminum.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, 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.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 1. Include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 degrees F and not exceeding 104 degrees F.
 - 2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL or a NRTL if approved by the Owner and/or Engineer, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- 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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 600-V ac.

4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

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. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. NEMA Type 7/9, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, UL 1203, NEMA 7BCD, 9EFG, rated for Class I, Division 2 locations, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Auxiliary Contact Kit for disconnects with upstream VFD: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

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. [ABB, Electrification Business.](#)
2. [Eaton.](#)
3. [Siemens Industry, Inc., Energy Management Division.](#)
4. [Square D; Schneider Electric USA.](#)

- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. .
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 167 degrees F rated wire.
- G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint or Owner approved color and paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1), gray baked enamel paint or Owner approved color and paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12), a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X 316 stainless steel if approved by Owner and Engineer), or copper-free cast aluminum alloy (NEMA 250 Types 7, 9).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X 316 stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, As indicated on the Drawings.
 - 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 with cover attached by Type 316 stainless steel bolts.

3.3 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.

- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare an Initial and
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY DRIVES

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 separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Requirements:
 - 1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.
 - 2. Section 266100 "Electrical Power House"

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. DDC: Direct digital control.
- C. EMI: Electromagnetic interference.
- D. LED: Light-emitting diode.
- E. NC: Normally closed.
- F. NO: Normally open.
- G. OCPD: Overcurrent protective device.
- H. PID: Control action, proportional plus integral plus derivative.
- I. RFI: Radio-frequency interference.
- J. VFC: Variable-frequency motor controller. See VFD.
- K. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
 - 1. Include dimensions and finishes for VFCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include mounting and attachment 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 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Required working clearances and required area above and around VFCs.
 - 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
 - 3. Show support locations, type of support, and weight on each support.
 - 4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
 - 1. Certificate of compliance.
 - 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.
- D. Product Certificates: For each VFC from manufacturer.
- E. Provide VFD in compliance with IEEE 519.
- F. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.
- G. Source quality-control reports.
- H. Field quality-control reports.

- I. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
 1. Include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - c. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Indicating Lights: Two of each type and color installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

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. ABB, Electrification Business.
 2. Eaton.
 3. Rockwell Automation, Inc.
 4. Schneider Electric USA, Inc.
 5. Siemens Industry, Inc., Building Technologies Division.

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 97 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 7. Ambient Temperature Rating: Not less than 32 degrees F and not exceeding 104 degrees F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 0.5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 2.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor-overtemperature fault.

- K. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- N. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 - 2. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

2.3 CONTROLS AND INDICATION

- A. Controls shall, as a minimum, perform the control logic indicated on the Contract Drawings and as specified herein.
- B. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1. As shown on the Drawings.
- C. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- D. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- E. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).

3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

F. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the SCADA system or other control systems:
 - a. 4- to 20-mA dc.
 - b. Potentiometer using up/down digital inputs.
 - c. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.

2.4 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

- B. Input Rectifier: Use a transistor-based Active Front End that uses a Selective Harmonic Elimination algorithm, mitigating the harmonics enough to meet IEEE-519 without the need for phase shifting transformers and multi-pulse diode rectifiers.
 - 1. Total current harmonic distortion shall not exceed 5 percent at the VFC input terminals in all load conditions.
 - 2. Insensitive to phase rotation, tolerant of line voltage imbalance up to 10 percent without affecting the harmonic mitigation or VFC output, and capable of operating the motor at full output with a 10 percent drop on input voltage.
 - 3. Use an LCL filter assembly to filter up to and including the 50th harmonic to reduce EMI/RFI emissions.
 - a. Include Passive Dampening in LCL filter assembly.
 - 4. Provide Active Resonance Detection and Protection to minimize any damage to the drive from supply side resonance.
- C. Output Filtering: Provide output dV/dt motor protection filters where shown on the Drawings.
- D. Output Filtering: Provide output sine wave motor protection filter where shown on the Drawings.

2.5 OPTIONAL FEATURES

- A. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.

2.7 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Unguarded.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
 - 4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- D. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- E. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with stainless steel intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.
- F. Spare control-wiring terminal blocks; wired.

2.8 ADDITIONAL CONSTRUCTION REQUIREMENTS

- A. Disconnect handle height shall not exceed NEC requirements with VFC is located on 4-inch high housekeeping pad.
- B. VFC's shall utilize 115 VAC control power for operator devices, cooling fans, motor space heaters and external control circuits. Control power transformer shall be fused on the primary and secondary. Control circuits shall be isolated from power circuits.
- C. VFC shall include a copper ground bus.
- D. All bus and exposed copper shall be tin plated.
- E. All floor mounted enclosures shall have complete 18 inch (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 12 inch (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.
- F. A switchable fluorescent light shall be provided within each floor mounted section of the enclosure.
- G. Barriers shall be provided on terminals that remain energized with the power disconnect OFF.
- H. All circuit boards shall be conformal coated to help protect them from hydrogen sulfide gases.
- I. Identification
 - 1. All wiring shall be numbered at each end with typed sleeve type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.
 - 2. Provide warning signs on terminals that are energized with the power disconnect OFF.

3. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.
4. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
5. Provide permanent warning signs as follows:
 - a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
 - b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".

2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
 1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. 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.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in control circuits if not factory installed.
- D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each VFC with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 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. Field test all the hardwired discrete and analog connections and any software communication (Ethernet, Profibus, ControlNet, Modibus etc) that are connect to remote

control equipment when the VFC is placed in remote. The manufacturer shall at a minimum verify with the proper testing equipment that the following can be achieved:

- a. The drive can be started and stopped remotely
- b. The drive can have its speed changed remotely
- c. The remote equipment can read the VFC discrete status information.
- d. The remote equipment can read the VFC speed feedback information.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

3.10 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.
- B. Replace all cabinet ventilation filters upon commencement of the Contract warranty period.

END OF SECTION 262923

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SECTION 263213.13 - DIESEL EMERGENCY ENGINE GENERATORS

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 packaged diesel engine generators for emergency use with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Outdoor engine generator enclosure.
 - 7. Vibration isolation devices.
 - 8. Finishes.
- B. Related Requirements:
 - 1. Section 262300 "Low-Voltage Switchgear" for controls, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

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.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.

4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 degrees F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
8. Sound test data, based on a free field requirement.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
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. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.
7. Include design loading calculations to support the recommended size of the engine generator based upon actual facility loads and specified maximum allowable voltage drop. Provide detailed sizing analysis. Clearly identify assumptions made for the loads being started/operated by the generator. When conducting the generator sizing analysis, set the maximum voltage drop of the generator to a maximum of 20 percent. The generator manufacturer and Contractor shall be responsible for obtaining all information to run the generator sizing analysis. Notify Engineer of any changes to the generator size. Submit the sizing analysis with the generator's initial submittal.

- C. Submit a copy of this specification confirming compliance with each paragraph. For deviations, provide detailed commentary to explain the deviation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Seismic Qualification Data: Certificates for engine generator, 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: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied

- enclosure, subbase-mounted fuel tank, and each piece of equipment not integral to the engine generator, 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.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

Include the following:

- a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- b. Operating instructions laminated and mounted adjacent to generator location.
- c. Training plan.

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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

- B. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

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. Caterpillar Inc.
 - 2. Cummins Power Generation.
 - 3. Kohler Power Systems.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:
 - 1. Comply with NFPA 37.
 - 2. Comply with NFPA 70.
 - 3. Comply with NFPA 99.
 - 4. Comply with NFPA 110 requirements for Level 2 EPSS.
- C. UL Compliance: Comply with UL 2200.
- D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
- E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

- F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 104 degrees F.
 - 2. Relative Humidity: Zero to 95 percent.
 - 3. Altitude: Sea level to 1000 feet.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. 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.
- C. EPSS Class: Engine generator shall be classified as a Class 24 according to NFPA 110.
- D. Power Output Ratings: Not less than as shown on the Drawings.
- E. Power Factor: 0.8, lagging.
- F. Frequency: 60 Hz
- G. Voltage: 480 V ac.
- H. Phase: Three-phase, four-wire wye.
- I. Induction Method: Turbocharged.
- J. Governor: Adjustable isochronous, with speed sensing.
- K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.
- L. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- M. Engine Generator Performance for Sensitive Loads:
 - 1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

- a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage, from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency, from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content, measured line to neutral, shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 60, system requirements.

2.4 DIESEL ENGINE

- A. Fuel: ASTM D975 diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid mounted.
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 degrees F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 25 dB at 500 Hz.
 - 2. Sound level measured at a distance of 23 feet from exhaust discharge after installation is complete shall be 75 dBA or less.

- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

- H. Starting System: 24 V electric, with negative ground.
 - 1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

- a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 degrees F to 140 degrees F to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- C. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- D. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- E. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 1. Tank level indicator.
 2. Fuel-Tank Capacity: Fuel for 24 hour(s) continuous operation at 100 percent rated power output.
 3. Leak detection in interstitial space.
 4. Vandal-resistant fill cap.
 5. Tank rails and lifting eye rated for the full dry weight of the tank, genset, and enclosure.
 6. Electrical stub up(s).
 7. Subbase tank shall include a welded steel containment basin, sized at a minimum of 110 percent of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
 8. Normal and emergency vents.
 9. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

- A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual-Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.
- E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator-disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:
 - 1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.
- F. Control and Monitoring Panel:
 - 1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 - 2. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.
 - b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, for each phase.
 - f. AC ammeter, for each phase.
 - g. AC frequency meter.
 - h. AC kW output, total and for each phase (indicate power flow direction).
 - i. AC kVA output, total and for each phase (indicate power flow direction).
 - j. AC kVAR output, total and for each phase.
 - k. AC power factor, total and for each phase (indicate leading or lagging condition).
 - l. Generator duty level (actual kW loading divided by kW nameplate).
 - m. Generator-voltage-adjusting rheostat.
 - 3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 2 system, including the following:

- a. Cranking control equipment.
- b. Run-Off-Auto switch.
- c. Control switch not in automatic position alarm.
- d. Overcrank alarm.
- e. Overcrank shutdown device.
- f. Low water temperature alarm.
- g. High engine temperature pre-alarm.
- h. High engine temperature.
- i. High engine temperature shutdown device.
- j. Overspeed alarm.
- k. Overspeed shutdown device.
- l. Low-fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

- m. Coolant low-level alarm.
- n. Coolant low-level shutdown device.
- o. Coolant high-temperature prealarm.
- p. Coolant high-temperature alarm.
- q. Coolant low-temperature alarm.
- r. Coolant high-temperature shutdown device.
- s. EPS load indicator.
- t. Battery high-voltage alarm.
- u. Low-cranking voltage alarm.
- v. Battery-charger malfunction alarm.
- w. Battery low-voltage alarm.
- x. Lamp test.
- y. Contacts for local and remote common alarm.
- z. Generator overcurrent-protective-device not-closed alarm.

G. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication as follows:
 - a. Ready.
 - b. Running.
 - c. Fault.
 - d. Fuel Low Level.
2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet TCP/IP.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
 - 1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
 - 2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
 - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
 - 1. Indicate ground fault with other engine generator alarm indications.
 - 2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H (105 degree C).

- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six-lead alternator.
- E. Range: Provide limited range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
 - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. Maintain voltage within 20 percent on one step, full load.
 - 3. Provide anti-hunt provision to stabilize voltage.
 - 4. Maintain frequency within 15 percent and stabilize at rated frequency within five seconds.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.
- M. Provide and monitor six (6) temperature sensors (RTD's), two (2) in each winding in the generator control panel specified herein. Provide monitors and relays.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 23 ft from the engine generator in a free field environment.
- C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads as follow:
 - 1. Wind Rating:
 - a. Ultimate Wind Speed, V_{ult} : 120 mph
 - b. Nominal Wind Speed, V_{nom} : 93 mph
- D. Mounting Base: Suitable for mounting on sub-base fuel tank.

- E. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 - F. Hardware: Stainless steel latches, hinges, and hardware.
 - G. Space Heater: Thermostatically controlled and sized to prevent condensation.
 - H. Provide a factory mounted and wired Transformer Load Center to serve the generator set and enclosure.
 - 1. Product Description: NEMA ST 20, transformer distribution unit with integral primary, secondary and branch circuit breakers.
 - 2. KVA Rating: 15 kVA.
 - 3. Primary Voltage: 480V, 3 phase, 3 wire.
 - 4. Secondary Voltage: 208Y/120V, 3 phase, 4 wire.
 - 5. Coil material: Copper.
 - 6. Encapsulation: Transformer core and coils completely resin encapsulated.
 - 7. Molded Case Circuit Breakers: UL 489, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for poles, Class A ground fault interrupter circuit breaker where indicated. Do not use tandem circuit breakers.
 - 8. Enclosure: NEMA ST 20, Type 1. Suitable for the environment in which the transformer is installed. Furnish lifting eyes or brackets.
 - I. Convenience Outlets: Two factory-wired 20A, 125 VAC, GFCI-protected duplex receptacles.
 - J. Lighting with switch: Provide factory-wired, weather-resistant LED lighting with 30-fc average maintained. Arrange to illuminate controls and accessible interior.
 - K. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
 - L. Insulation Flammability Classification: UL 94 HF1.
 - M. Muffler Location: Within enclosure.
 - N. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - 1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- 2.10 Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. VIBRATION ISOLATION DEVICES
- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.
 - B. IBC Compliance: Isolators complying with IBC requirements shall be specified in the equipment documentation, as well as the installation requirements for the unit.

- C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 2. Test generator, exciter, and voltage regulator as a unit.
 3. Full-load run.
 4. Maximum power.
 5. Voltage regulation.
 6. Transient and steady-state governing.
 7. Single-step load pickup.
 8. Safety shutdown.
 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure enclosure to anchor bolts installed in concrete bases.."
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
1. Install flexible connectors and steel piping materials.
 2. Insulate muffler/silencer and exhaust system components.
 3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.
- F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless steel flexible connector, and Schedule 40 black steel pipe with welded joints.
- G. Fuel Piping:
1. Copper and galvanized steel shall not be used in the fuel-oil piping system.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.
- C. Connect cooling-system water piping to engine generator with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.4 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

- B. Perform tests and inspections with the assistance of a factory-authorized service representative.

- C. Tests and Inspections:

- 1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

- a. Visual and Mechanical Inspection:

- 1) Compare equipment nameplate data with Drawings and the Specifications.
- 2) Inspect physical and mechanical condition.
- 3) Inspect anchorage, alignment, and grounding.
- 4) Verify that the unit is clean.

- b. Electrical and Mechanical Tests:

- 1) Perform insulation-resistance tests according to IEEE 43.
 - a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
- 2) Test protective relay devices.
- 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
- 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
- 5) Perform vibration test for each main bearing cap.
- 6) Conduct performance test according to NFPA 110.
- 7) Verify correct functioning of the governor and regulator.

- 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.

- 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

- a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 10. Noise-Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches, and run them concurrently.
- E. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest, reinspect as specified above.
- J. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.

3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.13

SECTION 263533 - POWER FACTOR CORRECTION 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 all work, materials and equipment required to construct and install low voltage active harmonic filter unit (AHF) as shown on the Drawings.
- B. AHF functions:
 - 1. Monitor the load current under review utilizing current transformers (CT's) mounted on the supply AC lines.
 - 2. Analyze the content of the supply current for harmonics from the 2nd to the 51st harmonic and determine the reactive current content representing displacement power factor and current balancing.
 - a. Inject cancellation for every harmonic order from 2nd to 51th order. AHF with designs to inject less than all harmonic orders are unacceptable.
 - 3. Field selectable to operate as a harmonic filter or provide power factor correction or supply current balancing or any combination of the three modes.
 - 4. Provide current balancing of AC supply for harmonic and reactive currents regardless of actual load distribution per phase.
 - 5. Have up to 30 seconds of logic ride thru in the event of power loss.
 - 6. Compatible with SPD, EMC filters, SCR (thyristor) snubber circuits, and switched mode power supplies (SMPS).
- C. Related Requirements:
 - 1. Section 260573 "Power System Studies."
 - 2. Section 262419 "Motor Control Centers."

1.3 DEFINITIONS

- A. AHF: Active harmonic filter unit.
- B. EMC: Electromagnetic Compatibility.
- C. HMI: Human Machine Interface.
- D. IGBT: Insulated gate bipolar transistor.
- E. LV: Low voltage.
- F. PCU: Power correction unit. Used interchangeably with the term AHF.

- G. SPD: Surge protective device.
- H. VFD: Variable frequency drive.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit required product data specific to each product and accessory proposed. In addition, include the following information:
 - 1. AHF sizing calculations shall be provided to confirm required harmonic mitigation and power factor correction performance for the AHFs proposed.
 - 2. AHF assembly rated input KVA and output KVA, topology, converter/inverter type, percent efficiency, operating characteristics, and electrical characteristics
 - 3. Maximum Btu heat release data and ambient cooling requirements
 - 4. Certification of UL conformity
 - 5. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For automatic power factor correction units.
 - 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.
 - 4. Wire Termination Diagrams and Schedules: Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer- and field-installed wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Harmonic Analysis Report: Project-specific calculations and statement of compliance with IEEE 519, latest revision.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Data: Certificates, for power capacitor banks, accessories, and components, from manufacturer.
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment: 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.
- D. Product Test Reports: Factory production test reports.

- E. Field quality-control reports.
- F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Lists of spare parts and replacement components recommended for storage at Project site.
 - b. Detailed instructions covering operation under both normal and abnormal conditions.
 - c. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy submittal.

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. Provide the minimum spare parts recommended by the manufacturer.
 - 2. Fuses: One for every three of each type and rating, but no fewer than three of each.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
- B. Manufacturer Qualifications:
 - 1. Firm engaged in the manufacture of this same type of equipment and whose products have been in satisfactory use in similar service for a minimum of ten years.
 - 2. ISO 9001 certification and an applicable quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.
 - 3. 24-hour, 7-days-a-week service, repair and technical support.
- C. Installer Qualifications:
 - 1. Firm having a minimum of five years of successful installation experience with projects utilizing AHFs similar in size and scope to what is required.
- D. Work Qualifications:
 - 1. All work performed, and all materials used in accordance with the National Electrical Code, and with applicable local regulations and ordinances.
 - 2. Equipment, assemblies and materials listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction and marked for intended use

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace active harmonic filter(s) that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

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. Harmonic Correction Unit (HCU2) by Eaton.
 - 2. Accusine PCS+ by Schneider Electric.
 - 3. HGA – HarmonicGuard Active by TCI.

2.2 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.
 - 1. AHF shall be defined as a power electronic device consisting of insulated gate bipolar transistors (IGBT) that switch into the AC lines to modulate its output to mitigate detrimental harmonic current and to correct the displaced reactive current (leading or lagging) and balance the current for the power source.
 - 2. The converter design shall be a three-level design to optimize performance and minimize heat loss.
- B. Comply with NFPA 70.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Power factor correction 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 and the unit will be fully operational after the seismic event."
- B. Provide the following performance per the basis of design sizing calculation method for non-linear loads each with a minimum impedance of 3%:
 - 1. THD(v) to be not more than 5% as contributed by the loads at the location of each AHF. Use a THD(v) set point to optimize performance of the AHF and maintain the 5% THD(v) set point.
 - 2. Displacement power factor (PF) 0.97 or better at the location of each AHF. Power factor must not go leading due to AHF performance. In addition:

- a. AHF to have a set point entry to maintain objective.
- b. AHF to have optimized displacement correction such that overcorrection or crossover of the PF will not occur.
3. AHF to provide negative sequence current correction to source current imbalance not more than 2% phase-to-phase after correction.

C. Service Conditions:

1. Operating Ambient Temperature Range:
 - a. Operating Temperature: Minus 40 to plus 104 deg F.
 - b. Maximum Altitude: 3300 feet.
 - c. Humidity: Zero to 95 percent, noncondensing.
 - d. Audible noise: 80 dBA at one meter from enclosure.
 - e. Printed circuit board assembly protection: all PCBs to have conformal coating.
2. AHF sizing and ratings:
 - a. Capable of operating with an input voltage of 380 volts AC to 480 volts AC, +10%, -15% at each nominal voltage.
 - b. Capable of operating at an AC supply frequency of 50 Hz or 60 Hz, +/- 3 Hz.
 - c. Phase rotation insensitive to detect phase rotation and align output accordingly.
 - d. Heat losses not to exceed more than 3 percent of the unit kVAR rating.
 - e. AHF amperage output amperage ratings shall be one of the following:
 - 1) A minimum of 60, 120, 200, or 300 amperes from 380 to 480 VAC.
 - f. Up to 10 units of any size combination paralleled to inject current according to the information received from one set of supply current transformers (CTs). Each unit field selectable for operation as master or slave. If one unit is offline for maintenance or faulted, the remaining units shall automatically adjust the total output to make up for the offline unit(s).

2.4 ACTIVE HARMONIC FILTER UNIT

- A. UL listed according to UL 508.
- B. Enclosure: The AHF shall be incorporated into the motor control center assemblies.
- C. Features:
 1. AHF shall be designed with a current limiting function to protect the IGBT's.
 - a. When the current limit level is attained on any harmonic order, a message shall be displayed indicating the output capacity is operating at maximum.
 - b. Operation shall continue indefinitely at this reduced level without trip or degradation of AHF.
 2. AHF shall have automatic restart capability upon power loss return and fault resets.
 - a. Fault trip limit shall occur after 5 restarts within a 5 minute period.
 - b. Automatic restart shall occur for the following faults and may include other faults: AC line overvoltage, AC line power loss, and AC line phase imbalance, over temperature, under temperature, and DC bus overvoltage.
 3. Upon occurrence the fault trip limit, AHF shall stop output current production and lock out restart until the fault is manually cleared.
 4. AHF shall incorporate an over temperature output roll back that shall reduce the total output current to reduce power component heating in order to maintain maximum current correction at the elevated temperatures within the electrical system.

- a. AHF shall monitor the incoming air temperature and invoke a hard trip of the unit at 124°F.
- b. Cooling Architecture: Separate cooling arrangement shall be made for the heat sinks. The clean and dry air intake for PCB's should not mix with the air for the heat sinks. The heat sinks shall be mounted in a separate plenum.
5. Operator Interface:
 - a. Door mounted human machine interface (HMI) with touch screen control rated NEMA 4-12 (IP65), dust tight and liquid resistant.
 - b. Run/stop control from every screen.
 - c. Oscilloscope feature to display:
 - 1) Three sets of data may at a time.
 - 2) Up to twenty predefined parameters can be chosen for each curve.
6. Performance trend curves displayed for:
 - a. load total RMS current
 - b. load RMS harmonic current per phase
 - c. AHF harmonic current output per phase
 - d. AC mains voltage per phase
 - e. THDi
 - f. TDD
 - g. load RMS reactive current
 - h. AHF RMS reactive current output
7. Bar graphs shall be provided for display of the mains and load harmonic current amplitudes per harmonic order.
8. Selected internal curves provided for diagnostic and performance checks.

2.5 HUMAN MACHINE INTERFACE

- A. HMI to display:
 1. Operating and setup parameters and event/fault messages in plain English, no cryptic codes or symbols are permitted on the display. Display includes:
 2. Mains voltage and CT current.
 3. Parameter adjustment (password protected).
 4. Event log with time and date stamp. Event log via the stop function or power-off. A minimum of 100 events to be stored.
- B. External communications via an RJ45 connectors to include:
 1. Modbus TCP/IP remote run/stop and display of operating parameters, set up parameters and diagnostic functions.
 2. Safety feature to lock out all other forms of control during service and commissioning.
 3. Display a flashing warning screen in the event of a fault.
 4. Download of pertinent parameters to a USB memory device to permit remote diagnostic evaluations and to save unit set up parameters.
- C. HMI to include, but not be limited to, an on-board commissioning guide with automatic detection the following features:
 1. Check for proper AC line phase rotation. No specific phase rotation required.
 2. Test for CT phase rotation and polarity. Lockout of operation if rotation cannot be achieved
 3. AHF shall automatically calibrate the CT for optimum harmonic cancellation performance.

4. Perform at full capacity for a period of 15 minutes to validate components.
5. In the event, any of the above cannot be reconciled, lock out AHF function until commissioning agent corrects, verifies, and clears each test
- 6.

2.6 CURRENT TRANSFORMER

A.

B. Split core type current transformers (CT) installed as defined herein and as shown on the Electrical Drawings. CT properties:

1. A minimum of two current transformers per AHF location are required and mounted on phases A & B of the mains. If phase to neutral loads are connected on a 4-wire system, three CT's are required.
2. Primary current ratings of the CT according to full load current rating of the circuit on which installed.
3. Current transformer ratio as shown on the Drawings. Secondary rating: 5 amperes.
4. Current transformers rated for 50 to 400 hertz.
5. 1% or better (metering class) accuracy.
- 6.

2.7 WARNING LABELS

A. Electrical Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

1. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - a. Location designation.
 - b. Nominal voltage.
 - c. Flash protection boundary.
 - d. Hazard risk category.
 - e. Incident energy.
 - f. Working distance.
 - g. Engineering report number, revision number, and issue date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment exterior and interior prior to installation. Report damage and do not install any equipment that is structurally, moisture, or mildew damaged.

- B. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. Indicate acceptance of the areas and conditions as approved by the Installer.
- D. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- E. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.2 INSTALLATION

- A. For installation as part of motor-control center, comply with the installation requirements of that Section.
- B. Install arc-flash labels as required by NFPA 70.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Test and adjust controls and safeties.
- D. Replace damaged or malfunctioning controls and equipment.
- E. Certify in writing prior to scheduling functional demonstration testing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations and is ready for operation.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain AHF.

END OF SECTION 263533

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protections system for the following:
 - 1. San Gabriel WWTP:
 - a. Administration Building.
 - b. Coordinated Electrical House I.
 - c. Coordinated Electrical House II.
 - d. Coordinated Electrical House III.
 - e. Sodium Bisulfite Facility.
 - f. Dewatering Building.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 - 2. Include raceway locations needed for the installation of conductors.
 - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 - 4. Include roof attachment details, coordinated with roof installation.
 - 5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Lightning protection cabling attachments to roofing systems and accessories.
 - 2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
 - 3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

- B. Qualification Data: For Installer.
- C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For lightning protection system to include in maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
 - b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.
 - B. Completion Certificate:
 - 1. UL Master Label Certificate.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY.

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. Harger Lightning & Grounding.
 - 2. National Lightning Protection.
 - 3. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.
- B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with NFPA 780, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Aluminum unless otherwise indicated.
2. 1/2-inch diameter by 18 inches long.
3. Rounded tip.
4. Integral base support.

B. Class 1 Main Conductors:

1. Aluminum: 98,600 circular mils in diameter.

C. Secondary Conductors:

1. Aluminum: 41,400 circular mils in diameter.

D. Ground Loop Conductor: As indicated on Drawings.

E. Ground Rods: As listed under Section 260526.

F. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.

D. Ground Ring Electrode: As indicated on Drawings.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors or high compression crimp.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Perform inspections as required to obtain a UL Master Label for system.
 - 2. Perform inspections to obtain an LPI certification.
- B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 265119 - LED INTERIOR LIGHTING

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 types of LED luminaires:
 - 1. Downlight.
 - 2. Linear industrial.
- B. Related Requirements:
 - 1. Section 266100 "Electrical Power House.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire 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.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) 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. Luminaires.
 2. Suspended ceiling components.
 3. Structural members to which luminaires will be attached.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, 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.
- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each type of luminaire, for tests performed by a qualified testing agency.
- F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 degrees F.
 - 1. Relative Humidity: Zero to 100 percent.
- B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE 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. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles.
 - 1. Label shall include the following lamp characteristics:
- C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. Refer to Light Fixture Schedule on the Drawing for other requirements.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 - 1. 1. Manufacturer's standard grade.
 - 2. 2. Manufacturer's standard type, ASTM A240/A240 M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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 luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 - 1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Suspended Luminaires:

1. Ceiling Mount:

- a. Pendant mount with 5/32-inch-diameter adjustable aircraft cable supports.
- b. Hook mount.

2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

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. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

- a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
 - b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment 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.
- C. Product Schedule:
1. For emergency lighting units. Use same designations indicated on Drawings.
 2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) 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. Luminaires.
 2. Suspended ceiling components.
 3. Structural members to which equipment will be attached.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.
- E. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Two year(s) from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
 2. Warranty Period for Self-Powered Exit Sign Batteries: Two years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- 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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Refer to Light Fixture Schedule on the Drawing for other requirements.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions.
 - 2. Designed to permit relamping without use of tools.
 - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

2.3 METAL FINISHES

- A. 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.

2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
 2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213

SECTION 265619 – LED EXTERIOR LIGHTING

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. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
- 2. Luminaire supports.
- 3. Luminaire-mounted photoelectric relays.
- 4. Delegated Design.

- B. Related Requirements:

- 1. Section 266100 “Electrical Power House.”

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.

- 1. Arrange in order of luminaire designation.
- 2. Include data on features, accessories, and finishes.
- 3. Include physical description and dimensions of luminaire.
- 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 DELEGATED DESIGN SUBMITTALS

A. For luminaire supports:

1. Include design calculations for luminaire supports.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which luminaires will be attached.
3. Building features.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

D. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

- E. Source quality-control reports.
- F. Sample warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.8 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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer, as defined in Sections 013300 “Submittal Procedures” and 014000 “Quality Requirements”, to submit the items listed in the DELEGATED DESIGN SUBMITTALS Article.

2.2 LUMINAIRE 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61.
- F. Bulb shape complying with ANSI C79.1.
- G. Refer to Light Fixture Schedule on the Drawing for other requirements.
- H. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.

- B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- F. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.4 FINISHES

- A. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

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 luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

END OF SECTION 265619

SECTION 266100 - ELECTRICAL POWER HOUSE

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. Pre-fabricated electrical walk-in enclosure, referred to as the enclosure or Power House within this specification for Coordinated E-House I, Coordinated E-House II, and Coordinated E-House III.
2. Enclosure accessories.
3. Delegated Design.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete foundation and pad.
2. Section 262300 "Low-Voltage Switchgear"
3. Section 262419 "Motor Control Centers"
4. Section 262923 "Variable-Frequency Drives"
5. Section 406717 "Industrial Enclosures"
6. Section 462113 "Multi-Rake Bar Screens"
7. Section 462363 "Grit Classifying and Washing Equipment"
8. Division 26 for electrical materials and equipment.

1.3 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.4 ACTION SUBMITTALS

- A. Include with submittal copy of this specification confirming compliance with each paragraph.
- B. Product Data: For each type of product.
 1. Include product data sheets and catalog numbers for HVAC equipment, receptacles, lighting, and other accessories.
- C. Shop Drawings:

1. Include plans, elevations, sections, mounting details, installation and anchoring requirements, fasteners, and other 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.
4. Grounding system plan.
5. Building electrical plan, showing conduit, cable tray, wire tray, subfloor wireway, and any other means of wiring transit. Including conduit entrance locations.

D. Calculations:

1. Heating and Cooling: For sizing of HVAC units.
2. Lighting: For illuminance levels.
3. Anchor and Mounting Bolt Design: Calculations and details.

1.5 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For anchorage details of enclosure.
- B. Qualifications Statement: Submit qualifications for licensed professional.

1.6 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Installation instructions.
- C. Field quality-control reports.
- D. Manufacturer's warranties.
- E. Building inspection certificate.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC systems.

1.8 QUALITY ASSURANCE

- A. Delegated Design Engineer: Licensed professional engineer experienced in design of specified Work and licensed in the State of Texas.
- B. Manufacturer of assembly must be ISO 9001 certified or have a quality management system in place comparable to the requirements of ISO 9001.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Ship power house, material, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
- B. Protect finishes and components against damage, weather elements, and condensed water vapor. Do not remove protection until work area is substantially free of construction dust and debris.
- C. Manufacturer shall supervise offloading at the site in the presence of the Contractor.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer and Installer agree to repair or replace components that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Factory fabricated, all-weather walk-in enclosure with environmental control, specifically designed to house electrical equipment along with other equipment as indicated on the Drawings and noted herein. Provide all equipment and accessories unless otherwise noted.
- B. Coordinated E-House I Requirements: Coordinate with other Section suppliers for final equipment dimensions. Provide the following equipment:
 - 1. Switchgear SWGR-2
 - 2. Motor Control Center MCC-1
 - 3. Motor Control Center MCC-2
 - 4. PLC-SGB Enclosure
 - 5. Grit Basin Master Control Panel MCP-2110-1
- C. Coordinated E-House II Requirements: Coordinate with other Section suppliers for final equipment dimensions. Provide the following equipment:
 - 1. Motor Control Center MCC-3
 - 2. Variable Frequency Drive VFD-WWP-01
 - 3. Variable Frequency Drive VFD-WWP-02
 - 4. Bar Screen Master Control Panel MCP-2000-1
- D. Coordinated E-House III Requirements: Coordinate with other Section suppliers for final equipment dimensions. Provide the following equipment:
 - 1. Motor Control Center MCC-4
 - 2. Space for future 36"Wx24"D enclosure.
- E. Intended to be delivered to the project site as a complete assembly.

- F. Intended to be off-loaded and installed at the project site with a crane making a single point lift using suitable rigging. Provide with appropriate lifting lugs and jacking plates.
- G. Coordinate with actual dimensions of equipment to be installed in enclosure.

2.2 MANUFACTURERS

- A. Manufacturer Qualifications: Same manufacturer as the motor control centers and switchgear. Manufacturer takes complete responsibility for equipment or enclosures purchased from third parties.
- 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. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements", to submit the items listed in the DELEGATED DESIGN SUBMITTALS Article.
- B. General Design Standards:
 - 1. ASCE 7-10: Minimum Design Loads for Buildings and Other Structures.
- C. Wind Design:
 - 1. Ultimate Design Wind Speed V_{ult} (3 second gust): 120 mph.
 - 2. Nominal Design Wind Speed, V_{asd} : 93 mph.
 - 3. Risk Category: III.
 - 4. Wind Exposure Category: C.
 - 5. Internal Pressure Coefficient: +/- 0.18.
- D. Roof Design:
 - 1. Insulation / Heat Transfer: R-38, minimum.
 - 2. Snow Load: 8 psf.
 - 3. Slope roof and provide drip edges.
- E. Wall Assembly Insulation / Heat Transfer: R-20, minimum.
- F. Floor Insulation: R-6, minimum. Polyurethane spray foam insulation.
- G. The building shall be designed to include loads induced by the HVAC, mechanical, process equipment, piping sprinklers, exhaust system, and other such devices shown on the plans and as specified. Additional girts or purlins shall be designed and placed in convenient locations for

attachment of all devices or equipment. Contractor shall provide building manufacturer with the equipment loads and other information that is needed for the building design.

2.4 GENERAL REQUIREMENTS

- A. Enclosure may be concrete or metal, as long as the intent and performance requirements are met.
- B. Enclosure Rating: NEMA 4 with sloping roof, drip edges, appropriate gasketing and animal guards, and an asphalt base undercoating on the exterior bottom.
- C. When structural elements are metal, they shall be structural quality pre-galvanized sheet steel, with all members continuously welded at all joints.
- D. Doors:
 - 1. Two-man doors, minimum dimension 3 feet x 7 feet, one at end each of the structure.
 - 2. Insulated, double walled aluminum, fastened with full length Type 316 stainless steel hinge.
 - 3. Panic-type door hardware.
 - 4. Automatic door closer.
 - 5. Lockable.
 - 6. Drip shield above doors.
 - 7. Door jams with adjustable gasketing around door frame for proper seal.
 - 8. Door thresholds with flexible gaskets from weather protection.
 - 9. Door Hardware: Type 316 stainless steel.
- E. For equipment requiring rear access, provide access doors with 3-point latching system and stainless-steel padlockable handles. Provide drip shields and gasketing per previous paragraph.
- F. Provide minimum clear floor area of 4 feet x 4 feet in front of each personnel door.
- G. Provide two Type 316 stainless steel ground pads located at opposite corners of enclosure skid with provisions for NEMA hole pattern lug.
- H. Provide removable steel cover plates over conduit entrance areas.
- I. Landings and Stairs:
 - 1. Provide to meet building code when enclosure is set on 4-inch high concrete pad.
- J. Exterior Enclosure Color: To be selected from manufacturer's standards during shop drawing approval.
- K. Interior Enclosure Color: To be selected from manufacturer's standards during shop drawing approval.

2.5 MARKING AND IDENTIFICATION

- A. Control wiring: Identify at each end with type-written heat shrinkable wire markers.
- B. Load Centers and Panelboards: Type written directory.
- C. “Danger High Voltage / Keep Out” Signs: On each door.

2.6 ELECTRICAL

- A. Electrical components, devices, and accessories to be listed and labeled as defined in NFPA 70, by a qualified testing agency, and in accordance with the intended location and application.
- B. Interior Lights:
 - 1. Type: LED industrial 4-foot fixtures with protective lenses, 120VAC.
 - 2. Illumination requirement: 50-foot candles measured 2.5 feet above floor.
 - 3. Emergency battery backup fixture: Minimum of two, at each entry door.
 - 4. Control: Toggle switches (3-way) located inside and next to each entry door.
- C. Exterior Lights:
 - 1. Type: LED with emergency battery backup, 120VAC.
 - 2. Control: Photocell.
- D. Interior Receptacles:
 - 1. Type: NEMA 5-20R, duplex, 20A, 120VAC, GFCI, specification grade.
 - 2. Location: At each entry door and as indicated on Drawings.
- E. Exterior Receptacles:
 - 1. Type: NEMA 5-20R, duplex, 20A, 120VAC, WR, GFCI, specification grade, with weatherproof while in-use protective cover.
 - 2. Location: As indicated on Drawings.
- F. Equipment: Provide appropriately sized transformer, and panelboard to provide all auxiliary power to enclosure. Incoming auxiliary power will be powered from 480VAC motor control center located within enclosure. Include in auxiliary power circuits:
 - 1. Lights.
 - 2. Receptacles. Each receptacle to be on its own circuit.
 - 3. HVAC.
 - 4. PLC cabinet, 120VAC.
- G. Circuitry:
 - 1. Refer to Section 260519 – Low-Voltage Electrical Power Conductors and Cables for cable requirements.
 - 2. Refer to Section 260529 – Hangers and Supports for Electrical Systems.
 - 3. Refer to Section 260533 – Raceways and Boxes for Electrical Systems.

4. Refer to Section 260536 – Cable Trays for Electrical Systems.
5. Run circuitry in enclosed raceways or surface mounted rigid aluminum conduit. Use XHHW-2 copper wire for enclosure accessory circuits.

H. Grounding:

1. Include a ground wire with all circuits.
2. Use No. 12 AWG solid wire for all receptacle circuits.
3. Provide #4/0 green insulated copper ground wire from ground bar(s) to exterior ground pads.

2.7 HVAC

- A. Refer to HVAC schedule sheet H-2 and specification section 238113.13 FL for HVAC system requirements.

2.8 ADDITIONAL ACCESSORIES

- A. Provide portable hand-carried fire extinguishers as indicated on the Drawings.
- B. Provide rubber floor mats directly in front of all electrical equipment for entire length of the equipment.
 1. Meet voltage ratings of equipment.

2.9 SURFACE PREPARATION AND SHOP COATINGS

- A. Clean all non-current carrying metal parts of enclosure of weld spatter and other foreign material and provide hot iron phosphate chemical treatment.
- B. Utilize manufacturer's standard procedures and processes.
- C. Paint entire outdoor exterior assembly with same color (i.e., either all ANSI 61 or all ANSI 49).

2.10 SOURCE QUALITY CONTROL

- A. All accessory system components shall be completely factory assembled, wired, and tested prior to shipment.
- B. Test and inspect assembled equipment, by a qualified testing agency, for building code compliance. Affix certification label.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosure on concrete pad, level to manufacturer's tolerances.
- B. Use Type 316 stainless steel hardware if exposed to outdoor conditions.
- C. Anchor enclosure per manufacturer's instructions.
- D. Remove temporary lifting angles, lugs, and shipping braces. Cover holes.
- E. Touch up damaged paint finishes.
- F. Make wiring interconnections as required.
- G. Caulk seams, cracks, and openings to exterior.

3.2 ADJUSTING

- A. Adjust doors and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
- B. Adjust interior and exterior lighting controls.
- C. Lubricate hardware and other moving parts.
 - 1. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 266100