

NORTH VILLAGE SPECIAL SERVICE DISTRICT

Invitation for Bids

Cover Sheet

General Information		
Project Name	Coyote Lane Sewer Lift Station	
Project Description	The North Village Special Service District ("NVSSD") desires to construct a sewer lift station and approx. 1,352' of 8" and 15" PVC gravity sewer lines. Work includes construction of a sewer lift station and concrete wet well including two 20HP dry pit submersible chopper sewer pumps and all related piping, site work and appurtenances.	
Contract Type	Construction – Unit Prices/Lump Sum (See Price Form)	
Procurement Process Information		
Contract Administrator	Dave Fuller 5360 Old Hwy 40 Heber City, Utah 84032 dave@jssd.us <i>All communications regarding this solicitation must be through the Contract Administrator.</i>	
Basis of Award	Award of contract will be made to the low Responsive and Responsible bidder.	
Submittal Instructions	Email bid to the Contract Administrator in a .pdf file.	
IFB Schedule		
• NVSSD Issues Invitation for Bids		June 23, 2022
• Deadline to submit Bids/Public Bid opening		July 11, 2022 1:00 p.m.
Included as part of this IFB		
Part A – Project Information The following documents will accompany the Invitation for Bids: • Construction plans for sewer lift station and pipelines		
Part B – Bid Content		
Part C – Standard Terms of Solicitation		
Part D – Construction Agreement • Exhibit A – General Conditions • Exhibit B – Supplemental Conditions		

• Exhibit C – Insurance Requirements
Part E – Forms • Price Form • Information Required of Bidders
Part F – Technical Specifications • Technical Specifications • Geotechnical Report

NORTH VILLAGE SPECIAL SERVICE DISTRICT

Invitation for Bids

Part A – Project Information

1. The Special Service District

The North Village Special Service District (“NVSSD”) is a special service district organized pursuant to Utah Code Ann. § 17D-1-101 *et seq.* NVSSD provides culinary water and sanitary sewer services in portions of Wasatch County, Utah. The Wasatch County Council serves as the governing body of NVSSD, which is managed by a General Manager.

2. The Project

This project includes the construction of a sewer lift station and approx. 1,352’ of 8” and 15” PVC gravity sewer lines. Work includes construction of a sewer lift station and concrete wet well including two 20HP dry pit submersible chopper sewer pumps and all related piping, site work and appurtenances.

3. Schedule

NVSSD Issues Invitation for Bids: June 23, 2022
Non-mandatory Site Visit: July 6, 2022, 1:00 pm
(Location – NVSSD Offices - 5388 N. Old Hwy 40, Heber City, Utah 84032)
Bids Due.....July 11, 2022, 1:00 p.m.
Recommendation for Award at NVSSD Board Meeting: July 12, 2022
Notice of Award July 14, 2022
Notice to Proceed.....July 28, 2022
Substantial Completion.....November 30, 2022
Final Completion December 30, 2022

4. Project Information

The combined project has the following components:

- Sewer Lift Station – (2) 20 HP dry pit submersible sewer chopper pumps located inside a concrete and stick-wood frame building
- 65’ of 8” PVC Sewer Force Main
- 850’ of 15” PVC Gravity Sewer Line
- 502’ of 8” PVC Gravity Sewer Line

The following documents accompany the Invitation for Bids:

- Construction plans for the sewer lift station and pipelines
- Technical Specifications (Part F)
- Geotechnical Report (Part F)

NORTH VILLAGE SPECIAL SERVICE DISTRICT

Invitation for Bids

Part B – Bid Content

1. BID CONTENT

A. Unit Price Bid Schedule

Bidders to complete Price Form included in Part E – Forms.

Bidders to sign and date Price Form.

B. Information Required from Bidders

Bidders to complete and submit with Price form Information Required of Bidders included in Part E – Forms.

C. Bid Bond

Bidders to include with bid a Bid Bond (5% of Total Bid Amount). No particular form of bond is required, but the bond must be issued by a surety licensed in the State of Utah.

NORTH VILLAGE SPECIAL SERVICE DISTRICT

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Part C – Standard Terms of Solicitation

1. INSTRUCTIONS TO BIDDERS

A. Submission of Bids.

Bids will be received by the Contract Administrator via email, or as otherwise arranged between the Bidders and the Contract Administrator. The Contract Administrator will log the date and time of each Bid received. Any Bid received after the Deadline to Submit Bids listed on the IFB Cover Sheet will be considered non-responsive. It is the responsibility of the Bidder to ensure that its Bid is received by the Contract Administrator by the specified time.

B. Minimum Standards.

This IFB sets forth the minimum requirements that all Bids must meet. Failure to submit Bids in accordance with this IFB may render the Bid unacceptable or non-responsive. NVSSD may, in its sole discretion, waive minor irregularities in a Bid that do not alter the quality or quantity of the information provided.

C. Confidential, Protected, and Public Information

In accordance with Utah Code Section 63G-2-305(6) of the Government Records Access and Management Act ("GRAMA"), information related to this procurement will not be made public until after execution of the contract with the successful Bidder. Procurement information includes the Bids submitted by Bidders in response to this IFB and any accompanying documentation, as well as records maintained by NVSSD during the procurement process.

NVSSD will maintain a process to ensure confidentiality for the duration of this procurement. If the Bidder submits information in its Bid that it believes is "trade secret," the Bidder must follow the procedure set forth in Section 63G-2-309 of GRAMA.

Additionally, for ease of Bid evaluation, NVSSD requests that each Bidder also follow the steps identified below:

- 1) Clearly mark all trade secret information as such in its Bid at the time the Bid is submitted, and state in a cover letter that the "DOCUMENT CONTAINS TRADE SECRET INFORMATION," and identifying each section and page which has been so marked;

2) Include a statement with its Bid justifying the Bidder's determination that certain records are trade secret information for each record so defined;

3) In addition to the Bid copies submitted in accordance with the Submittal Instructions on the IFB Cover Sheet, submit one electronic copy of the Bid that has all the trade secret information deleted from the Bid and label such copy of the Bid "Public Copy." If a Bidder submits a Bid containing no trade secret information, no "Public Copy" need be submitted. However, any Bidder that submits a Bid containing no trade secret information must so certify in a cover letter to its Bid; and

4) Defend any action seeking release of the records it believes to be trade secret information and indemnify, defend, and hold harmless NVSSD and its agents and employees from any judgments awarded against NVSSD or its agents and employees in favor of the party requesting the records, including any and all costs connected with that defense. This indemnification survives NVSSD's cancellation or termination of this procurement or award and subsequent execution of the contract. In submitting a Bid, the Bidder agrees that this indemnification survives as long as the trade secret information is in possession of NVSSD.

All records pertaining to this procurement will become public information after execution of the Contract, unless such records are identified as trade secret information as specified above. No liability will attach to NVSSD or its agents for the errant release of trade secret information by NVSSD or its agents under any circumstances.

D. Submitting Questions to NVSSD

Questions and Requests for changes to the IFB must be submitted via email. All questions must be directed to the Contract Administrator identified on the IFB Cover Sheet.

E. Requests for Approved Equals or Changes

Whenever a brand, manufacturer, or product name is indicated in this IFB, they are included only for the purpose of establishing identification and a general description of the item. Wherever such names appear, the term "or approved equal" is considered to follow.

Requests for Approved Equals must be submitted to the Contract Administrator via email.

Any request for an approved equal must be fully supported with technical data, test results, or other pertinent information as evidence that the substitute offered is equal or better than the IFB requirement.

It should be understood that specifying a brand name, components, and/or equipment in this IFB will not relieve the Bidder from its responsibility to provide the product in accordance with the performance specifications, warranty, and contractual requirements. The Bidder shall notify NVSSD of any inappropriate brand name, component, and/or equipment that may be called for in this IFB and shall propose a suitable substitute for consideration.

F. Multiple or Alternative Bids

Submission of multiple or alternative Bids, except as specifically called for in the IFB, may render all such Bids non-responsive and may cause the rejection of some or all of such Bids.

G. Withdrawal of Bids

A Bidder may withdraw its Bid before the Bid due date without prejudice to itself by submitting a written request for its withdrawal to the Contracts Administrator. If a Bidder withdraws its Bid prior to the Deadline to Submit Bids, NVSSD will return the Bid to the Bidder.

H. Cost of Bids

NVSSD is not liable for any costs incurred by Bidders in the preparation of Bids submitted in response to this IFB.

I. Examination of Request for Bids

The submission of a Bid constitutes an acknowledgment upon which NVSSD may rely that the Bidder: (i) has thoroughly examined and is familiar with the IFB, including any contractual terms included in the IFB, (ii) is familiar with any work site identified in the IFB, and (iii) has reviewed and inspected all applicable statutes, regulations, ordinances, and resolutions addressing or relating to the goods and services to be provided hereunder. The failure or neglect of a Bidder to receive or examine such documents, work sites, statutes, regulations, ordinances, or resolutions will in no way relieve the Bidder from any obligations with respect to the Bidder's Bid or to any contract awarded pursuant to this IFB. No reduction or modification in the Bidder's obligations will be allowed based upon a lack of knowledge or misunderstanding of this IFB, work sites, statutes, regulations, ordinances, or resolutions.

J. Firm Offer

Unless otherwise stated in this IFB, submission of a Bid constitutes an offer to provide the goods or services described in the IFB, for the price set forth in the Bid. Such offer must be good and firm for a period of ninety (90) days after the Deadline to Submit Bids.

K. No Collusion

By submitting a Bid, the Bidder represents and warrants that its Bid is genuine and not a sham, and that the Bidder has not colluded with any other parties regarding this procurement process. If NVSSD learns that the Bid is not genuine, or that the Bidder did collude with other parties, or engaged in any anti-competitive or fraudulent practices in connection with this procurement process, NVSSD may immediately terminate any resulting contract and seek any remedies available in equity or at law.

2. SELECTION PROCESS

A. Changes to the IFB Schedule

NVSSD may make changes to the IFB Schedule, in its sole discretion. Deadlines shown on the IFB Cover Sheet that apply to NVSSD are estimates only, and may be adjusted by NVSSD in its sole discretion.

B. Addenda to the Request for Bids

NVSSD may make changes to the IFB, by issuing a written addendum to the IFB.

C. Public Opening

This is an IFB and, as such, the Bids submitted in response to this IFB will be publicly opened.

D. NVSSD's Procurement Options

Based on submitted information, NVSSD may do or take any of the following actions, without limitation:

- award to the low responsive and responsible bidder,
- ask for more information or Clarifications before making a selection;
- if a material error in the IFB is discovered during the process, NVSSD may issue an addendum to all Bidders that have submitted Bids requesting revised Bids based upon the corrected IFB;
- decline to accept any Bid;
- re-advertise;
- cancel the procurement; or
- elect to otherwise procure the needed services in accordance with NVSSD policy and procedures.

E. Responsiveness

Bids that are conditional, that attempt to modify the IFB requirements, that contain additional terms or conditions, or that fail to conform to the requirements or specifications of the IFB may be considered non-responsive.

F. Responsibility

NVSSD will not select a Bidder who is deemed by NVSSD, in its sole discretion, to lack the ability or responsibility to perform successfully under the terms of the contract. Such determination of responsibility may encompass management, technical, legal, and financial matters.

G. Checking References

NVSSD reserves the right to contact any reference specifically named by the Bidder in its Bid or any other additional references as deemed appropriate by NVSSD, including references suggested by the Bidder's named references or references known to NVSSD through its own knowledge of the industry.

H. Requests for Clarification

The Bidder shall provide accurate and complete information to NVSSD. If information is incomplete, appears to include a clerical error, or is otherwise unclear, NVSSD may either (i) declare the Bid non-responsive, (ii) evaluate the Bid as submitted, or (iii) issue a Request for Clarifications to the Bidder stating the information needed and a date and time by which the information must be provided. If the Bidder does not respond to the Request for Clarifications in a timely manner, or if the Bidder's response is deemed to be insufficient by NVSSD, in its sole discretion, then NVSSD may declare the Bid non-responsive.

NORTH VILLAGE SPECIAL SERVICE DISTRICT

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Part D – Construction Agreement

CONSTRUCTION AGREEMENT

This Construction Agreement (“**Agreement**”) is between the North Village Special Service District, a special service district organized pursuant to Utah Code Ann. §§ 17D-1-101 *et seq.* (the “**District**”), and _____, a _____, (“**Contractor**”).

RECITALS

- A. The District is engaged in a project to construct the Coyote Lane sewer lift station and associated piping (the “**Project**”).
- B. On or about June 23, 2022, the District issued an Invitation for Bids (the “**IFB**”), seeking interested parties to submit Bids for the work required by the Project.
- C. The Contractor submitted the lowest responsive and responsible bid, in the amount of \$_____ (the “**Bid Amount**”).
- D. The District and the Contractor desire to enter into this Agreement to define their respective roles and responsibilities with respect to the Project.

AGREEMENT

Therefore, the parties agree as follows:

1. Scope of Work. (a) Contractor shall perform the Work. In the Contract Documents, “**Work**” means all design, procurement, construction, installation, startup, commissioning, and other services required by the Contract Documents, including procuring and furnishing all material, equipment, services and labor reasonably inferable from the Contract Documents as necessary to complete the Project.

(b) The Work will take place at the Site. In the Contract Documents, “**Site**” means the District property identified in the construction drawings included in the IFB.

2. Schedule. (a) Contractor shall commence the Work within seven (7) days of Contractor’s receipt of a Notice to Proceed (“**NTP**”) from the District. The District is not required to issue a NTP until all insurance, bonding, and other required documentation is submitted and deemed acceptable by the District.

(b) The District may issue a limited NTP on a portion of the Work, and may issue a series of limited NTPs to provide for progression of the Work in phases. Issuance of a limited NTP will not be deemed to require the District to issue any subsequent NTPs, and will not be deemed to obligate the District to complete the Project or to pay Contractor for any portion of the Work not encompassed by an NTP issued by the District.

(c) The Contractor shall achieve Substantial Completion of the Work no later than November 30, 2022 (the “**Substantial Completion Date**”). In the Contract Documents, “**Substantial**

Completion” means that the equipment has been installed and Work completed in accordance with the Contract Documents, such that the District can use the sewer lift station and associated pipelines for their intended purpose.

(d) The Contractor shall achieve Final Completion of the Work no later than December 30, 2022. In this Contract Documents, **“Final Completion”** means that all Work is complete in accordance with the Contract Documents, as determined by the District’s Engineer, including but not limited to, final completion of all punch list items and delivery of all documents in accordance with the Contract Documents.

(e) Time is of the essence with respect to the dates set forth in this section.

(f) Contractor acknowledges that if Substantial Completion is not attained by the applicable Substantial Completion Date, the District will suffer damages that are difficult to measure and determine with precision. If Substantial Completion is not attained by the Substantial Completion date, Contractor shall pay the District, or the District may deduct from any money due to Contractor, **\$500.00** as liquidated damages for each Day that Substantial Completion extends beyond the Substantial Completion Date.

3. Price and Payment. (a) Payment for the Work will be based on the Contractor’s Price Form submitted in response to the IFB. For line items bid on a unit price basis, the District will compensate Contractor at the unit price set forth on the Contractor’s Price Form, based on the actual measured quantities in the Work. For line items bid on a lump sum basis, the District will compensate Contractor based on the lump sum set forth on the Contractor’s Price Form (such unit price and lump sum bids, collectively, the **“Contract Price”**). The procedures for invoicing and payment are set forth in Article 4 of the General Conditions.

(b) For purposes of calculating changes in the Contract Price pursuant to Section 7.7 of the General Conditions, Contractor will be entitled to a markup of 10% for overhead and profit. Subcontractors will be entitled to a markup of 10% for overhead and profit, but the cumulative markup may not exceed 20%. An increase or decrease in the Total Bid Amount as set forth on the Contractor’s Price Form, as a result of actual quantities for unit price line items being different from the estimated quantities on the Price Form, will not be a basis for the Contractor charging an additional markup.

4. Contract Documents. (a) The Contract Documents consist of the following:

(1) All written amendments and Change Orders to this Agreement executed in accordance with Article 7 of the General Conditions;

(2) This Agreement, including the following exhibits,

Exhibit A – General Conditions

Exhibit B – Supplemental Conditions

Exhibit C – Insurance Requirements

(3) The IFB, including each Part and Section thereof;

(4) The Contractor's Bid in response to the IFB.

(b) The parties intend that the Contract Documents include and provide for all aspects of the Work that are necessary for the proper initiation, performance, and substantial completion of the Project by the Contractor, prior to the Substantial Completion Date, and for the Contract Price. The parties intend that the Contract Documents be interpreted in harmony so as to avoid conflict, with words and phrases interpreted in a manner consistent with construction and design industry standards.

(c) Where any two or more parts or provisions of Contract Documents conflict or are inconsistent with each other, the Contract Documents will be interpreted in the manner most likely to have been intended by the District. For example, where any two or more parts of the Contract Documents impose upon Contractor differing standards or obligations with respect to substantially the same subject-matter, then the more stringent standard or obligation will apply in the absence of any intention to the contrary.

(d) Contractor acknowledges that, prior to the execution of this Agreement, it has carefully reviewed the Contract Documents for errors, omissions, conflicts or ambiguities (each, a "**Discrepancy**"), and is not aware of any Discrepancies as of the execution of this Agreement. If the Contractor becomes aware of a Discrepancy, the Contractor shall immediately notify the District's Project Director of that Discrepancy in writing. the District's Project Director shall promptly resolve the Discrepancy in writing. Contractor's failure to promptly notify the District of an apparent discrepancy will be deemed a waiver of Contractor's right to seek an adjustment of the Contract Price and Substantial Completion Date due to the discrepancy.

(e) The Contract Documents form the entire contract between the District and the Contractor and by incorporation in this Agreement are as fully binding on the parties as if repeated in this Agreement. The Contract Documents are the only contract between the District and the Contractor with respect to the Project, and supersede any other or prior agreements, commitments or representations regarding the Project. No oral representations or other agreements have been made by the parties except as specifically stated in the Contract Documents.

5. Representatives of the Parties. (a) The District designates Steve Jackson as its Project Manager. The District's Contract Administrator for this Agreement is Max Covey. The District's Engineer is Steve Jackson. Questions or correspondence regarding the contractual aspects of this Agreement should be directed to the Contract Administrator, at the address set forth in section 12. The District's Project Manager, and Contract Administrator are referred to collectively as the "**the District Representatives**."

(b) Contractor designates _____ as its Project Manager, and _____ as its Senior Representative (collectively, the "**Contractor Representatives**").

6. Bonds and Insurance. (a) Contractor shall obtain and maintain the insurance coverages set forth in Exhibit C, and shall comply with the obligations set forth in Exhibit C.

(b) The Contractor shall provide to the District a performance bond and a payment bond (the “**Bonds**”), each in an amount equal to 100% of the Bid Amount. Contractor shall provide the Bonds to the District within ten (10) days after execution of this Agreement, and prior to commencing any Work.

7. E-Verify. (a) Contractor hereby certifies that it has registered and is participating in the Status Verification System to verify the work eligibility status of Contractor’s new employees that are employed in the State of Utah, as required by Utah Code Ann. § 63G-12-302. Contractor shall require any Subcontractors that perform Work in the State of Utah to certify to Contractor by affidavit that they have verified the employment status of each new employee through the Status Verification System.

8. Notices. (a) To be deemed valid, any notice, request, claim, demand or other formal communication between the parties pertaining to any legal or contractual dispute (“**Legal Notices**”) must be in writing and addressed as follows:

If to the District:

North Village Special Service District
ATTN: Max Covey
5360 Old Hwy 40
Heber City, UT, 84032

With a required copy to:

Parsons Behle & Latimer
ATTN: Rob Hughes
201 South Main Street, Suite 1800
Salt Lake City, UT 84111.

If to the Contractor:

(b) To be deemed valid, Legal Notices must be given by one of the following methods: (i) by delivery in person (ii) by a nationally recognized next day courier service, (iii) by first class, registered or certified mail, postage prepaid.

(c) Either party may change the address at which that party desires to receive written notice by delivery of Legal Notice of such change to the party as set forth above. Legal Notices will be deemed effective on delivery to the notice address then applicable for the party to which the Legal Notice is directed, provided, however, that refusal to accept delivery of a Legal Notice or the inability to deliver a Legal Notice because of an address change that was not properly communicated shall not defeat or delay the effectiveness of a Legal Notice.

(d) Nothing in this section 8 is intended to limit or prohibit the parties from engaging in informal verbal or written communications using email or other means of communication

9. Entire Agreement. This Agreement constitutes the entire agreement between the parties with respect to the subject matter herein, and supersedes any and all other prior and contemporaneous agreements and understandings between the parties, whether oral or written. The terms of this Agreement supersede any additional or conflicting terms or provisions that may be set forth or printed on the Contractor's invoices or other standard forms or documents that may subsequently be used to implement, record, or bill for services under this Agreement. The terms of this Agreement prevail in any dispute between the terms of this Agreement and the terms printed on any such standard forms or documents.

10. Counterparts. The parties may execute this Agreement in any number of counterparts, each of which when executed and delivered will constitute a duplicate original, but all counterparts together will constitute a single agreement.

11. Effectiveness; Date. The Agreement will become effective when all parties have fully signed it. The date of this Agreement will be the date it is signed by the last individual to sign it (as indicated by the date associated with that individual's signature).

Each individual is signing this Agreement on the date stated opposite that individual's signature.

NORTH VILLAGE SPECIAL SERVICE DISTRICT

By: _____
Max Covey
General Manager

Date: _____

By: _____

Date: _____

Exhibit A

General Conditions

1.0 General

1.1 **Cooperation.** The District and Contractor commit at all times to cooperate fully with each other, and proceed on the basis of trust and good faith, so as to permit each party to realize the benefits afforded under the Contract Documents.

1.2 **Professional Standards.** Contractor shall perform the Work in a good and workmanlike manner, and shall use reasonable skill, care, and diligence. If the Work includes professional services, Contractor shall perform those services in a professional manner, using at least that standard of care, skill and judgment that can reasonably be expected from similarly situated professionals. Work, equipment, materials, and supplies that are not expressly specified in the Contract Documents must conform to the best commercial practice for the type of Work, equipment, materials, or supplies in question. Contractor shall be solely responsible for the Work, whether performed by Contractor directly or by Contractor's Subcontractors.

1.3 **Definitions.** Terms that are defined anywhere in the Contract Documents have the same definition in all the Contract Documents, including in these General Conditions. In the Contract Documents, the following definitions apply:

“Agreement” means the document signed by Contractor and the District, in which these General Conditions are incorporated as an exhibit.

“Basis of Design Documents” means those preliminary drawings, concept design drawings, technical requirements, performance requirements, project criteria, or other documents that are (i) included in the Contract Documents, and (ii) serve as the basis or starting point for design services to be performed by Contractor, if any.

“Building Codes” means the most recent version of all applicable local, state, national, and international building codes.

“Construction Documents” means the final drawings and specifications that set forth in detail the requirements for construction of the Project.

“Contract” means the entire contract between the District and the Contractor, including all of the Contract Documents and every Part and Section thereof.

“Contract Documents” means those documents designated as Contract Documents in the Agreement.

“Contract Times” means the Substantial Completion Date, the Final Completion Date, and any other deadlines for completion of the Work, or a part thereof, as set forth in the Contract Documents.

“Contractor” means the entity that has entered into a contract with the District to perform engineering, procurement, construction, installation, and other services as detailed in the Contract Documents.

“Day” means a calendar day unless otherwise specifically noted in the Contract Documents.

“Engineering Standards” means the most recent version of all applicable standards published by engineering or construction industry groups such as ANSI, AISC, ASME, AWWA, IEEE, TEMA, NFPA, ASHRAE, UL, ARI, ASTM, CTI, SMACNA, and AMCA.

“Force Majeure Events” means unpredictable events beyond the control of Contractor that impede performance of the Work, such as riots, earthquakes, epidemics, and extreme weather events.

“General Conditions” means this document.

“Legal Requirements” means the most recent version of all applicable federal, state, and local laws, codes, Building Codes, ordinances, rules, regulations, orders and decrees of any government or quasi-government entity having jurisdiction over the Project or Site, the practices involved in the Project or Site, or any Work.

“Site” means the land or premises on which the Project is located, and might be more particularly defined in the Agreement.

“Subcontractor” means any person or entity retained by Contractor as an independent contractor to perform a portion of the Work, including materialmen and suppliers, and includes any person or entity retained by a Subcontractor.

2.0 Contractor’s Services

2.1 General Services.

2.1.1 Contractor’s Project Manager shall be reasonably available to the District and shall have the necessary expertise and experience required to supervise the Work. Contractor’s Project Manager shall communicate regularly with the District and shall be vested with the authority to act on behalf of Contractor.

2.1.2 Contractor shall provide the District with a monthly status report detailing the progress of the Work, including (i) whether the Work is proceeding according to schedule, (ii) whether Discrepancies, conflicts, or ambiguities exist in the Contract Documents that require

resolution, (iii) whether health and safety issues exist in connection with the Work; (iv) other items that require resolution so as not to jeopardize Contractor's ability to complete the Work for the Contract Price and within the Contract Times.

2.1.3 Unless a schedule for the execution of the Work has been attached to the Agreement as an exhibit at the time the Agreement is executed, Contractor shall prepare and submit, within thirty (30) days of the execution of the Agreement, a schedule for the execution of the Work for the District's review and approval. The schedule must indicate the dates for the start and completion of the various stages of Work, including any engineering, manufacturing, testing, and shipment of the principal items of equipment, and the dates when the District information and approvals are required to enable Contractor to achieve the Contract Times. The District may identify one or more dates on the schedule when Contractor's actual progress on the Work will be measured against the scheduled progress (those dates, "**Milestone Dates**").

2.1.4 The schedule shall be revised as required by conditions and progress of the Work, but such revisions shall not relieve Contractor of its obligations to complete the Work within the Contract Times, as such dates may be adjusted in accordance with the Contract Documents. The District's review of, and response to, the schedule shall not be construed as relieving Contractor of its complete and exclusive control over the means, methods, sequences and techniques for executing the Work.

2.1.5 Contractor shall at all times employ such force, plant, materials, and tools as necessary to assure compliance with the Contract Documents and to progress the Work at such a rate as to assure achievement of the Contract Times.

2.2 Design Services. If the Work includes any engineering or design services sections 2.2.1 through 2.2.8 apply.

2.2.1 Contractor shall provide the necessary design services, including architectural, engineering and other design professional services, for the preparation of the required drawings, specifications and other design submittals to permit Contractor to complete the Work consistent with the Contract Documents. Contractor shall ensure that design services are performed by qualified, licensed design professionals employed by Contractor, or by qualified, independent licensed design consultants procured by Contractor.

2.2.2 Contractor and the District shall, consistent with any applicable provision of the Contract Documents, agree upon any interim design submissions that the District may wish to review, which interim design submissions may include design criteria, drawings, diagrams, and specifications setting forth the Project requirements. Interim design submissions must be consistent with the Basis of Design Documents, as the Basis of Design Documents may have been changed through the design process set forth in this Section 2.2.2. On or about the time of the scheduled submissions, Contractor and the District shall meet and confer about the submissions, with Contractor identifying during such meetings, among other things, the evolution of the design

and any changes to the Basis of Design Documents, or, if applicable, previously submitted design submissions. Changes to the Basis of Design Documents, including those that are deemed minor changes under Section 7.4.1, shall be processed in accordance with Article 7. Minutes of the meetings, including a full listing of all changes, will be maintained by Contractor and provided to all attendees for review. Following the design review meeting, the District will be entitled to at least ten (10) working days to review and comment on the interim design submissions and meeting minutes.

2.2.3 To the extent not prohibited by the Contract Documents or Legal Requirements, and with the approval of the District, Contractor may prepare interim design submissions and Construction Documents for a portion of the Work to permit construction to proceed on that portion of the Work prior to completion of the Construction Documents for the entire Work.

2.2.4 Contractor shall submit proposed Construction Documents to the District, which must be consistent with the latest set of interim design submissions, as such submissions may have been modified in a design review meeting and recorded in the meeting minutes. The parties shall have a design review meeting to discuss, and the District shall review and approve, the Construction Documents in accordance with the procedures set forth in Section 2.2.2 above. Contractor shall submit copies of approved Construction Documents to the District prior to commencement of construction.

2.2.5 The District's review and comment on interim design submissions, meeting minutes, and the Construction Documents is for the purpose of mutually establishing a conformed set of Contract Documents compatible with the requirements of the Work. Neither the District's review nor approval of any interim design submissions, meeting minutes, and Construction Documents shall be deemed to transfer any design liability from Contractor to the District, nor relieve Contractor from the obligation to perform the Work and complete the Project in full compliance with the Contract Documents.

2.2.6 Upon completion of the Work, and as a condition to receiving final payment pursuant to Section 4.7, Contractor shall prepare and provide to the District a final set of as-built drawings, depicting the Project as completed, including all changes to the Project made subsequent to the approval of the Construction Documents.

2.2.7 All drawings, specifications, interim design submissions, Construction Documents, and other documents furnished by Contractor to the District pursuant to the Contract Documents (those documents, the "**Work Product**") are deemed to be instruments of service and Contractor shall retain the ownership and intellectual property rights therein.

2.2.8 Upon the District's payment in full for the Work required for Contractor to prepare any Work Product, Contractor will be deemed to have granted to the District a perpetual license to use that Work Product in connection with the construction, occupancy, and maintenance of the Project.

2.3 Procurement Services. If the Work includes any procurement services, sections 2.3.1 through 2.3.7 apply

2.3.1 In the performance of its procurement services, Contractor shall at all times be and act subject to the direction and control of the District as the District's authorized limited agent. By "limited agent" the parties mean that Contractor shall have authority to represent and act for the District for the purpose of procuring equipment, materials, and supplies as necessary to complete the Project. Contractor will maintain direct supervision and complete charge and control of and responsibility for its personnel in the performance of these procurement services.

2.3.2 Equipment, materials, and supplies purchased by Contractor, and paid for by the District, that are left over at the Site or any other location where the Work is completed, shall remain the sole property of the District. Contractor shall endeavor to purchase only sufficient material, equipment and supplies that are necessary for the Project. Contractor shall endeavor to purchase on the basis that surplus materials may be returned to the vendor at a reasonably discounted price. If requested by the District, Contractor shall be responsible for disposing of all surplus equipment, materials, and supplies and shall credit the Project with the amount recovered. Contractor shall not, at any time or for any reason, knowingly or negligently acquire equipment, materials, or supplies unreasonably in excess of what will be required for completion of the Work, and Contractor shall manage Subcontractors so as to prevent them from acquiring equipment, materials, or supplies unreasonably in excess of what is required to complete the Work. Any amount of materials, equipment or supplies that is acquired in an unreasonable quantity because of negligence in contravention of the foregoing sentence shall be paid for by Contractor out of amounts otherwise payable to Contractor under the Contract, directly or by way of set off by the District.

2.3.3 Contractor shall determine and then requisition and purchase or otherwise arrange for the provision of all equipment, materials, supplies, and construction tools and equipment, except as may be furnished by the District, required for the accomplishment of the Work. With regard to the procurement of equipment, materials, and supplies intended to become a permanent part of the Project, Contractor shall purchase such materials, equipment, and supplies as limited agent for, and on behalf of, and in the name of the District on terms consistent with this Contract and acceptable to the District. Contractor shall be responsible for all aforesaid items being furnished in accordance with the requirements of this Contract.

2.3.4 Contractor shall be responsible for arrival on the Site of all items described in the preceding section in such time as to avoid any delay in the continuous prosecution of the Work. Unless otherwise directed by the District, Contractor shall, in consultation with the District and the District's insurance advisors, purchase, or arrange for the purchase of, freight forwarder insurance or similar insurance for all items described in the preceding section.

2.3.5 For equipment furnished by the District to be incorporated in the Work, if any, Contractor shall assume responsibility for administration of any purchase order in connection therewith, with respect to inspection, expediting and delivery, and the resolution of technical problems relating to manufacture.

2.3.6 Unless otherwise agreed by the District in writing, Contractor shall cause title, possession, control and risk of loss of all equipment, materials, and supplies procured by or through Contractor to remain in third parties and not to pass or be deemed to pass to the District until such equipment, materials, and supplies arrive at or are delivered to the Site. Title to all equipment, materials, and supplies must pass to the District free and clear of any and all liens, encumbrances or claims whatsoever in favor of Contractor or any third parties.

2.3.6 Contractor shall be responsible for, and shall indemnify and hold the District harmless from, all export clearances and license fees in connection with the shipment to the United States of any equipment, materials, or supplies of foreign manufacture covered by this contract and any and all taxes, duties, imports, or similar charges levied or assessed by any governmental authority having jurisdiction upon or against such equipment, materials, or supplies or the transaction giving rise to such shipment, regardless of whether title to such equipment, materials, or supplies shall have passed to or become vested in the District.

2.3.7 The District shall have the right to approve the suppliers of equipment, materials and supplies covered by this Contract. Contractor shall allow the District to personally inspect the place of manufacture of any equipment, materials, or supplies, and to observe the manufacturing process and any tests performed on equipment, materials, or supplies covered by this Contract. Contractor shall provide the District with copies of inspection reports for equipment, material, equipment, and supplies covered by this Contract, and shall draw the District's attention to any potential problem areas.

2.4 Government Approvals, Permits, and Legal Requirements.

2.4.1 Unless otherwise provided in the Contract Documents to be the responsibility of the District, Contractor shall obtain and pay for all necessary permits, approvals, licenses, government charges and inspection fees required for the prosecution of the Work by any government or quasi-government entity having jurisdiction over the Project. Contractor shall provide reasonable assistance to the District in obtaining those permits, approvals, and licenses that are the District's responsibility, as set forth elsewhere in the Contract Documents.

2.4.2 Contractor shall perform the Work in accordance with all Legal Requirements and shall provide all notices applicable to the Work as required by the Legal Requirements.

2.4.2 Contractor shall take all necessary steps to prevent the filing of any mechanic's liens on any District property. If a lien of any nature arising from or related to the Work is filed

against any District property, the Contractor shall promptly take any and all actions necessary to cause such lien to be released or discharged.

2.5 Construction Services.

2.5.1 Contractor shall proceed with construction in accordance with the approved Construction Documents.

2.5.2 Unless otherwise provided in the Contract Documents to be the responsibility of the District or a separate contractor, Contractor shall provide through itself or Subcontractors the necessary supervision, labor, inspection, testing, start-up, material, equipment, machinery, temporary utilities and other temporary facilities to permit Contractor to complete construction of the Project consistent with the Contract Documents.

2.5.3 Contractor is responsible for securing the Site until Substantial Completion of the Project.

2.5.4 Contractor shall perform all construction activities efficiently and with the requisite expertise, skill and competence to satisfy the requirements of the Contract Documents. Contractor shall at all times exercise complete and exclusive control over the means, methods, sequences and techniques of construction.

2.5.5 Contractor shall employ only Subcontractors who are duly licensed and qualified to perform the Work consistent with the Contract Documents. The District may require Contractor to remove from the Project a Subcontractor, or anyone employed directly or indirectly by Contractor or a Subcontractor, if the District reasonably believes that the person or firm is not performing its assigned Work in a safe, careful, or timely manner.

2.5.6 Contractor is responsible for the proper performance of the Work of Subcontractors and any acts and omissions in connection with such performance. Nothing in the Contract Documents is intended or deemed to create any legal or contractual relationship between the District and any Subcontractor, including but not limited to any third-party beneficiary rights.

2.5.7 Contractor shall coordinate the activities of all of its Subcontractors. If the District performs other work on the Project or at the Site with separate contractors under the District's control, Contractor agrees to reasonably cooperate and coordinate its activities with those of such separate contractors so that the Project can be completed in an orderly and coordinated manner without unreasonable disruption.

2.5.8 Contractor shall keep the Site reasonably free from debris, trash and construction wastes to permit Contractor to perform its construction services efficiently, safely and without interfering with the use of adjacent land areas. Contractor shall remove materials and equipment from the Site as soon as they are no longer necessary. Upon Substantial Completion of the Work, or a portion of the Work, Contractor shall remove all debris, trash, construction wastes, materials,

equipment, machinery and tools arising from the Work or applicable portions thereof to permit the District to occupy the Project or a portion of the Project for its intended use.

2.6 Quality Assurance/Quality Control.

2.6.1 As a means of assuring that the performance of the Work fulfills the requirements of the Contract Documents, the Contractor and Contractor's Subcontractors shall implement a quality assurance and quality control program ("**QA/QC Plan**") for all the Work. The QA/QC Plan must provide assurance that design, procurement, manufacturing, shipping, construction, testing, storage, and examination of all equipment, materials, and services will comply with the requirements of the Contract Documents.

2.6.2 Contractor shall submit its QA/QC Plan to the District for review and approval within thirty (30) days of the execution of the Agreement.

2.6.3 Throughout the course of the Work, Contractor shall provide the District with access to Contractor's QA/QC personnel and processes to enable monitoring and quality auditing.

2.6.4 The QA/QC Plan is only an aid to achieving compliance with the Contract Documents and to documenting such compliance. The QA/QC Plan will not relieve Contractor of the responsibility to comply with other requirements of the Contract Documents.

2.7 Inspection and Approval by the District.

2.7.1 All Work done and all equipment, materials, and supplies are subject to inspection by the District to determine if they conform to the Contract Documents. The District shall at all times have access to the Work, including equipment, materials, and supplies being fabricated or stored off site. Contractor shall furnish at the Contractor's cost any facilities necessary for sufficient and safe access to the Work.

2.7.1 Inspections, tests, measurements, or other acts of the District are for the sole purpose of assisting the District in determining that the Work, equipment, materials, supplies, rate of progress, and quantities comply with the Contract Documents and/or Contractor's Applications for Payment. These acts or functions will not relieve the Contractor from performing the Work in full compliance with the Contract Documents nor relieve the Contractor from any of the quality, compliance, and responsibility for the Work assigned to it by the Contract Documents. No inspection by the District will constitute or imply acceptance or waiver of rights.

2.7.3 Any Work required to be inspected by the District prior to being covered, which is covered up without prior inspection or without prior consent of the District, must be uncovered and recovered by the Contractor, if requested by the District, at no cost to Owner, notwithstanding the provisions of Section 2.7.4.

2.7.4 Contractor shall provide the District with at least 48 hours advance written notice of the time at which the District must be present to perform an inspection. Failure to provide such notice will place the Contractor at risk for all consequences of non-inspection and having to uncover work.

2.7.5 The District may reject any nonconforming Work, equipment, materials, or supplies, and Contractor shall correct such rejected Work without additional compensation, even if the Work, equipment, materials, or supplies have been previously inspected or accepted by the District or even if the District failed to observe the unsuitable Work, equipment, materials, or supplies. Contractor shall bear all costs of correcting such Work, equipment, materials, or supplies, including the cost of necessary additional professional services and the cost of repairing or replacing all Work of separate contractors or Subcontractors damaged by such removal or correction.

2.7.6 If the Contractor does not promptly replace or correct such Work or material, the Owner may replace or correct the Work or material, and charge or deduct the cost of removal and replacement from any monies due to the Contractor, or recover such costs from the Contractor.

2.7.7 The District's exercise of any of its rights under this Section 2.7 will not relieve Contractor of its obligation to achieve the Contract Times, nor entitle Contractor to a Change Order.

2.8 Contractor's Warranty.

2.8.1 Contractor warrants to the District that the construction, including all materials and equipment furnished as part of the construction, shall be new (unless otherwise specified in the Contract Documents), of good quality, fit for their intended use as contemplated by the Contract Documents, in conformance with the Contract Documents, and free of defects in design, materials, and workmanship. Nothing in this warranty is intended to limit any manufacturer's warranty that provides the District with greater warranty rights than set forth in this Section or the Contract Documents. Contractor shall provide the District with all manufacturers' warranties upon Substantial Completion.

2.8.2 If Contractor becomes aware of any fault or defect in the Work, or non-conformance with the Contract Documents, Contractor shall give prompt written notice of that fault, defect, or non-conformance to the District.

2.8.3 Except as otherwise stated in the Contract Documents, Contractor shall correct any Work that is found to not be in conformance with the Contract Documents within a period of five (5) years from the date of Contractor's Application for Final Payment.

2.8.4 Contractor shall, within seven (7) days of receipt of written notice from the District that the Work is not in conformance with the Contract Documents, take meaningful steps to

commence correction of such nonconforming Work, including the correction, removal or replacement of the nonconforming Work and any damage caused to other parts of the Work affected by the nonconforming Work. Any such corrective work must be taken with due regard with the need to maintain service to the District's customers. If Contractor fails to commence the necessary steps within such seven (7) day period, the District, in addition to any other remedies provided under the Contract Documents, may provide Contractor with written notice that the District will commence correction of such nonconforming Work with its own forces or other contractors. If the District does perform, or cause to be performed, such corrective Work, Contractor will be responsible for all reasonable costs incurred by the District in performing such correction. If the nonconforming Work creates an emergency requiring an immediate response, including an outage or reduction in capacity, the seven (7) day period identified herein will be deemed inapplicable.

2.8.5 Contractor shall bear the cost of any corrective work described in Section 2.8.4, whether those costs are incurred by Contractor or by the District. Those costs include the costs of (a) locating and identifying the defective design, equipment, component, program, or device within the failed equipment, (b) removal, correction, or replacement including transportation charges, (c) retesting, and (d) providing any the District personnel necessary to facilitate the corrective work.

2.8.6 Whenever any defect covered by the Contractor's warranty has been corrected, or any defective or failed item has been repaired or replaced pursuant hereto, the five-year warranty period will recommence as to the repaired or replaced item.

2.8.7 The five-year period referenced in Section 2.8.3 above applies only to Contractor's obligation to correct nonconforming Work and is not intended to constitute a period of limitations for any other rights or remedies the District may have regarding Contractor's other obligations under the Contract Documents.

2.8.8 Notwithstanding anything in this Section 2.8 to the contrary, the District may elect to continue to use and operate any nonconforming Work or equipment until it can be taken out of service or until corrective Work can be performed. Any such election by the District will not relieve Contractor from any of its warranty obligations.

3.0 Site Conditions

3.1 Unless otherwise expressly provided in the Contract Documents to be part of the Work, Contractor is not responsible for any Hazardous Materials encountered at the Site, that were not brought onto the Site by the Contractor or Subcontractor. "**Hazardous Materials**" means any substance that is deemed a hazardous waste or substance under any Legal Requirement.

3.2 If Contractor discovers at the Site any substance the Contractor reasonably believes to be a Hazardous Material, Contractor shall immediately stop Work in the area of the discovery and immediately report the discovery to the District. The District shall determine how to deal with the Hazardous Material, and Contractor shall resume Work in the area when directed to do so by the District.

3.3 Contractor will be entitled to an adjustment to the Contract Price and/or Contract Times to the extent Contractor's cost and/or time of performance have been adversely impacted by the presence of Hazardous Materials.

3.4 Notwithstanding Sections 3.1 through 3.3, the District is not responsible for Hazardous Materials introduced to the Site by Contractor, its Subcontractors, or anyone for whose acts Contractor is responsible. To the fullest extent permitted by law, Contractor shall defend and indemnify the District from and against all claims, losses, damages, liabilities and expenses, including attorneys' fees and expenses, arising out of or resulting from those Hazardous Materials introduced to the Site by Contractor, its Subcontractors, or anyone for whose acts Contractor is responsible.

3.5 If Contractor encounters a Differing Site Condition, Contractor may request a Change Order to adjust the Contract Price and/or Contract Times, to the extent Contractor's cost and/or time of performance have been adversely impacted by the Differing Site Condition. **"Differing Site Condition"** means concealed or latent physical conditions at the Site that (i) materially differ from the conditions indicated in the Contract Documents, and (ii) are of an unusual nature, differing materially from the conditions ordinarily encountered and generally recognized as inherent in the Work.

3.6 Upon encountering a Differing Site Condition, Contractor shall provide prompt written notice to the District of such condition, which notice shall not be later than five (5) days after such condition has been encountered. Contractor shall, to the extent reasonably possible, provide such notice before the Differing Site Condition has been substantially disturbed or altered. Failure to promptly provide such notice will constitute a waiver of any claim for an adjustment to the Contract Times and Contract Price.

4.0 Payment

4.1 Schedule of Values.

4.1.1 Unless required by the District upon execution of this Contract, within ten (10) days of execution of the Agreement, Contractor shall submit for the District's review and approval a schedule of values for all of the Work. The Schedule of Values will (i) subdivide the Work into its respective parts, including but not limited to design, manufacture, and delivery of equipment

and materials, and engineering and construction services, (ii) include values for all items comprising the Work and, (iii) serve as the basis for monthly progress payments made to Contractor throughout the Work.

4.1.2 The District will timely review and approve the Schedule of Values so as not to delay the submission of the Contractor's first application for payment. The District and Contractor shall timely resolve any differences so as not to delay the Contractor's submission of its first application for payment.

4.2 Application for Payment.

4.2.1 To receive payment, Contractor shall submit to the District an Application for Payment requesting payment for all Work performed as of the date of the Application for Payment. Contractor shall not submit Applications for Payment more often than once per month. The Application for Payment must be accompanied by supporting documentation sufficient to establish, to the District's reasonable satisfaction, Contractor's entitlement to receive payment.

4.2.2 The Application for Payment may request payment for equipment and materials not yet incorporated into the Project, provided that (i) the District is satisfied that the equipment and materials are suitably stored at either the Site or another acceptable location, (ii) the equipment and materials are protected by suitable insurance, and (iii) upon payment, the District will receive the equipment and materials free and clear of all liens and encumbrances.

4.2.3 The Application for Payment will constitute Contractor's representation that the Work described therein has been performed consistent with the Contract Documents, has progressed to the point indicated in the Application for Payment, and that title to all materials and equipment will pass to the District free and clear of all claims, liens, encumbrances, and security interests upon the incorporation of the materials and equipment into the Project, or upon Contractor's receipt of payment, whichever occurs earlier.

4.3 Sales Tax

4.3.1 Contractor shall pay all applicable sales and use taxes, and shall itemize those amounts separately on each Application for Payment.

4.4 The District's Payment Obligations.

4.4.1 The District shall pay Contractor all amounts properly requested and documented within thirty (30) days of receipt of an Application for Payment.

4.4.2 Notwithstanding Section 4.4.1, the District may withhold a percentage of each payment as retention in accordance with applicable law.

4.4.3 Notwithstanding Section 4.4.1, if the District identified Milestone Dates pursuant to Section 2.1.3, and if Contractor's actual progress on the Work has fallen behind the scheduled

progress as of a Milestone Date, the District may withhold 10 percent of each subsequent payment, until Contractor has initiated remedial action to get the Work back on schedule, to the satisfaction of the District. Any amounts withheld under this section will be placed in an interest-bearing account, and the withheld money, plus accrued interest, will be released to Contractor when the Work is back on schedule, to be determined by the District in its reasonable discretion. No interest will be paid to the Contractor if the Contractor fails to meet a Substantial Completion Date. Remaining withheld payments under this section will be released to the Contractor upon Substantial Completion of the entire Work.

4.4.4. Notwithstanding Section 4.4.1, if the District determines that Contractor is not entitled to all or part of an Application for Payment as a result of Contractor's failure to meet its obligations hereunder, the District will notify Contractor in writing at least five (5) days prior to the date payment is due. The notice must indicate the specific amounts the District intends to withhold, the reasons and contractual basis for the withholding, and the specific measures Contractor must take to rectify the District's concerns. Contractor and the District will attempt to resolve the District's concerns prior to the date payment is due. If the parties cannot resolve such concerns, Contractor may pursue its rights under the Contract Documents, including those under Section 8 of these General Conditions. Contractor shall continue to perform the Work pending the resolution of any such dispute.

4.5 Contractor's Payment Obligations.

4.5.1 Contractor shall pay its Subcontractors and suppliers, in accordance with its contractual obligations to such parties, all the amounts Contractor has received from the District on account of their work. Contractor shall indemnify and defend the District against any claims for payment and mechanic's liens as set forth in Section 5.2.

4.6 Substantial Completion.

4.6.1 Contractor shall notify the District when it believes the entire Work is ready for Substantial Completion. Within five (5) days of the District's receipt of Contractor's notice, the District and Contractor will jointly inspect such Work to verify that it has met the requirements for Substantial Completion. If the Work meets the requirements for Substantial Completion, the District shall prepare and issue a Certificate of Substantial Completion that will set forth (i) the date of Substantial Completion of the Work or portion thereof, (ii) the remaining items of Work that have to be completed before Final Completion, if applicable, (iii) the remaining items of Work that have to be completed before final payment, and (iv) provisions (to the extent not already provided in the Contract Documents) establishing the District's and Contractor's responsibility for the Project's security, maintenance, utilities and insurance pending final payment.

4.6.2 Promptly after issuing the Certificate of Substantial Completion, the District shall release to Contractor all retained amounts, less an amount equal to two times the reasonable value of all remaining or incomplete items of Work as noted in the Certificate of Substantial Completion.

4.6.3 Upon Contractor's request or upon the District's own initiative, the District may, in its sole discretion, accept a portion of the entire Work as Substantially Complete. The provisions of Sections 4.6.1 and 4.6.2 will apply to that portion of the Work. The District's acceptance of a portion of the Work as Substantially Complete will not relieve Contractor of its responsibility for protection and care of the entire Work. In addition, before the District may take possession of or place into service a portion of the Work, the District and Contractor shall obtain the consent of their sureties, insurers, and any government authorities having jurisdiction over the Project.

4.6.4 Following Substantial Completion, the District may restrict Contractor's access to the Site. The District shall allow Contractor reasonable access to the Site in order for the Contractor to achieve Final Completion.

4.7 Final Payment.

4.7.1 When Contractor has achieved Final Completion of the Work, Contractor shall submit a Final Application for Payment and the following information:

4.7.1.1 An affidavit that there are no claims, obligations or liens outstanding or unsatisfied for labor, services, material, equipment, taxes or other items performed, furnished or incurred for or in connection with the Work which will in any way affect the District's interests;

4.7.1.2 A general release executed by Contractor waiving, upon receipt of final payment, all claims, except those claims previously made in writing to the District and remaining unsettled at the time of final payment;

4.7.1.3 Consent of Contractor's surety, if any, to final payment;

4.7.1.4 All operating manuals, warranties and other deliverables required by the Contract Documents; and

4.7.1.5 Certificates of insurance confirming that required coverages will remain in effect consistent with the requirements of the Contract Documents.

4.7.2 Upon making final payment, the District waives all claims against Contractor except claims relating to (i) Contractor's failure to satisfy its payment obligations, if such failure affects the District's interests, (ii) Contractor's failure to complete the Work consistent with the Contract Documents, including defects appearing after Substantial Completion, and (iii) the terms of any warranties required by the Contract Documents.

4.7.3 Final payment by the District constitutes an acknowledgment that warranties commence to run on the date of Contractor's Final Application for Payment.

4.7.4 Deficiencies in the Work discovered after Substantial Completion, whether or not such deficiencies would have been included on a punch list if discovered earlier, will be deemed

warranty Work. Contractor shall correct such deficiencies pursuant to Section 2.8, and the District may withhold from the final payment the reasonable value of completion of the deficient work until that work is completed.

5.0 Indemnification and Loss

5.1 Patent and Copyright Infringement.

5.1.1 Contractor shall defend any action or proceeding brought against the District based on any claim that the Work, or any part thereof, or the operation or use of the Work or any part thereof, constitutes infringement of any patent or copyright, now or hereafter issued. the District shall give prompt written notice to Contractor of any such action or proceeding and will reasonably provide authority, information and assistance in the defense of same. Contractor shall indemnify the District from and against all damages and costs, including but not limited to attorneys' fees and expenses awarded against the District or Contractor in any such action or proceeding. Contractor shall keep the District informed of all developments in the defense of such actions.

5.1.2 If the District is enjoined from the operation or use of the Work, or any part thereof, as the result of any patent or copyright suit, claim, or proceeding, Contractor shall at its sole expense take reasonable steps to procure the right to operate or use the Work. If Contractor cannot so procure such right within a reasonable time, Contractor shall promptly, at Contractor's expense, either (i) modify the Work so as to avoid infringement of any such patent or copyright or (ii) replace said Work with Work that does not infringe or violate any such patent or copyright.

5.1.3 Sections 5.1.1 and 5.1.2 above shall not be applicable to any suit, claim or proceeding based on infringement or violation of a patent or copyright arising from modifications to the Work by the District or its agents after acceptance of the Work.

5.1.4 The obligations set forth in this Section 5.1 shall constitute the sole agreement between the parties relating to liability for infringement of violation of any patent or copyright.

5.2 Payment Claim Indemnification.

5.2.1 Provided that the District is not in breach of its contractual obligation to make payments to Contractor for the Work, Contractor shall indemnify, defend and hold harmless the District from any claims or mechanic's liens brought against the District or against the Project as a result of the failure of Contractor, its Subcontractors, or others for whose acts Contractor is responsible, to pay for any services, materials, labor, equipment, taxes or other items or obligations furnished or incurred for or in connection with the Work. Within three (3) days of receiving written notice from the District that such a claim or mechanic's lien has been filed, Contractor shall

commence to take the steps necessary to discharge said claim or lien, including, if necessary, the furnishing of a mechanic's lien bond. If Contractor fails to do so, the District will have the right to discharge the claim or lien and hold Contractor liable for costs and expenses incurred, including attorneys' fees.

5.3 Contractor's General Indemnification.

5.3.1 Contractor shall indemnify and hold harmless the District and all of its officers and employees (the "**Indemnitees**") from and against any and all suits and causes of action, claims, charges, damages, demands, judgments, civil fines and penalties, or losses of any kind or nature whatsoever, for death, bodily injury or personal injury to any person, including the employees of Contractor and Subcontractors of any tier, or damage or destruction to any property caused by reason of the negligent acts, errors, omissions or willful misconduct incident to the performance of this Agreement on the part of the Contractor, Subcontractors of any tier, or any of their respective officers or employees.

5.3.2 The Contractor shall comply, and cause its Subcontractors to comply with all Legal Requirements, specifically including Legal Requirements relating to workplace safety. Contractor shall indemnify and hold harmless the Indemnitees from and against any and all suits and causes of action, claims, charges, damages, demands, judgments, civil fines and penalties, or losses of any kind or nature whatsoever, presented, brought or recovered against the Indemnitees or that may be incurred by the Indemnitees as a result of the Contractor's failure to comply with such Legal Requirements.

5.3.3 At the option of the affected Indemnitees, Contractor shall defend the affected Indemnitees against any and all suits and causes of action, claims, charges, damages, demands, judgments, civil fines and penalties, or losses of any kind or nature whatsoever, for which Contractor has an indemnification obligation. Subject to the approval of affected Indemnitees, which shall not be unreasonably withheld, the Contractor shall retain legal counsel for the purpose of defending any affected Indemnitees. Contractor shall not settle, discontinue, or allow judgment to be entered in any such suit or action without the written consent of the affected Indemnitee(s), which consent shall not be unreasonably withheld.

5.3.4 Contractor's indemnification obligations will not be limited or affected by any insurance Contractor is required to maintain pursuant to the terms of this Agreement.

5.4 Risk of Loss.

5.4.1 Contractor bears all risk of loss to the Project, including materials and equipment not yet incorporated into the Project, until Substantial Completion.

5.5 Bonds.

5.5.1 Contractor shall furnish and maintain a satisfactory performance bond. The performance bond must guarantee the faithful performance of the Contract in a manner satisfactory to the District, and that materials furnished and quality of Work shall be free from defects.

5.5.2 Contractor shall furnish and maintain a satisfactory labor and material payment bond. The bond must guarantee that Subcontractors and suppliers of equipment and materials will be paid.

5.5.3 The Bonds must be executed by a responsible corporate surety, authorized to issue such bonds in the State of Utah. Unless otherwise provided in the Agreement, the bonds must be in an amount of not less than 100 percent of the Contract Price. The bonds must be accompanied by a current copy of the surety company's license issued by the Utah Insurance Department. The Bonds must extend to Work performed pursuant to Change Orders, and to purchase of optional quantities of equipment and supplies, even if such changes are made or options exercised without notice to the surety.

5.5.4 If the District at any time deems the Bonds or other surety to be insufficient or unsatisfactory, the District may require the Contractor to replace, increase, or supplement the Bonds or other surety. In that event, the District will not be required to make further payment to the Contractor until the Contractor replaces, increases, or supplements the Bonds or other surety to the District's satisfaction.

6.0 Time

6.1 Obligation to Achieve the Contract Times.

6.1.1 Contractor shall commence performance of the Work and achieve the Contract Times in accordance with the Agreement.

6.2 Delays to the Work.

6.2.1 If Contractor is materially delayed in the performance of the Work due to Differing Site Conditions, Hazardous Materials, Force Majeure Events, changes in the Work, or acts or omissions of the District or anyone under the District's control (including separate contractors), the Contract Times for performance shall be reasonably extended by Change Order.

6.2.2 In addition to Contractor's right to a time extension for those events set forth in Section 6.2.1 above, Contractor will also be entitled to an appropriate adjustment of the Contract Price provided, however, that the Contract Price will not be adjusted for Force Majeure Events unless otherwise provided in the Agreement.

7.0 Changes

7.1 Change Orders.

7.1.1 Contractor shall not undertake any activity that materially changes the Work, or materially deviates from the requirements of the Contract Documents, except as authorized in this Article 7. Any costs incurred by Contractor without authorization as provided in this Article 7 will be considered non-reimbursable.

7.1.1 A Change Order is a written instrument, signed by the District and Contractor, issued after execution of the Agreement, stating their agreement on a change in the scope of the Work, the Contract Price, and/or the Contract Times.

7.1.2 All changes in the Work authorized by applicable Change Order shall be performed under the applicable conditions of the Contract Documents. The District and Contractor shall negotiate in good faith and as expeditiously as possible the appropriate adjustments for such changes.

7.2 Requests for Information.

7.2.1 The District may deliver to Contractor Requests for Information (“**RFI**”) regarding specified changes in the Work. Upon receipt of the RFI, Contractor shall prepare an estimate of the cost and schedule impact of the change. Upon agreement between the District and Contractor on the scope of the change to the Work, and the adjustment, if any, to the Contract Price and/or Contract Times, the District and Contractor shall execute a written Change Order.

7.3 Direction or Authorization to Proceed.

7.3.1 A Direction or Authorization to Proceed (“**DAP**”) is a written order prepared and signed by the District directing or authorizing a change in the Work prior to agreement on an adjustment in the Contract Price and/or the Contract Times. The District may issue a DAP at any time, and Contractor shall undertake the Work as set forth in the DAP, and in accordance with the Contract Documents.

7.3.2 The District and Contractor shall negotiate in good faith and as expeditiously as possible the appropriate adjustments for the DAP. Upon reaching an agreement, the parties shall prepare and execute an appropriate Change Order reflecting the terms of the agreement.

7.4 Minor Changes in the Work.

7.4.1 Minor changes in the Work do not involve an adjustment in the Contract Price and/or Contract Times and do not materially and adversely affect the Work, including the design, quality, performance and workmanship required by the Contract Documents. Contractor may make minor changes in the Work consistent with the intent of the Contract Documents, provided, however, that Contractor shall promptly inform the District, in writing, of any such changes and record such changes on the documents maintained by Contractor.

7.5 Constructive Changes.

7.5.1 A written or verbal order from the District that causes a material change in the Work will be treated as a Change Order under this Article if Contractor delivers to the District's Project Manager a written notice identifying (i) the date, circumstances, and source of the order, and (ii) an explanation of why the Contractor regards the order to be a change order. To be valid, such notice must be delivered within twenty-one (21) Days of the order.

7.6 Equivalent Materials.

7.6.1 Whenever in the Contract Documents any particular equipment, material, or process is indicated or specified by a patent or proprietary name, or by a trade or brand name, or by the name of a manufacturer, such wording is used for the purpose of facilitating description of the equipment, material, or process required, and for fixing the standard of quality required. The parties intend that any such wording be deemed to be followed by the words "or equivalent."

7.6.2 The Contractor may propose an equivalent alternative to any equipment, material or process specified in the Contract Documents. To make such a proposal, the Contractor must submit a written request to the District for approval at least 30 days prior to the use of such equipment, material, or process. The request shall contain the name of the manufacturer, brand, catalog number or other designation, description of the materials used, detailed descriptions, general drawings, photographs, or illustrations, and all other information showing that the equipment, material, or process is equivalent to that specified. If requested by the District, the Contractor shall have such equivalent material or equipment tested as to its quality, strength, durability, design, efficiency, finish, service, or chemical characteristics. The District may approve or deny any such request in its sole discretion.

7.6.3 If the District approves a Contractor request to use an equivalent alternative to any equipment, material, or process specified in the Contract Documents, it may do so on the condition that the Contract Price be reduced to account for the cost savings to the Contractor.

7.6.4 Any change to the requirements of the Contract Documents as described in this Section 7.6 must be documented in a Change Order.

7.7 Contract Price Adjustments.

7.7.1 The increase or decrease in Contract Price resulting from a change in the Work will be determined by one or more of the following methods:

7.7.1.1 Unit prices set forth in the Agreement or as subsequently agreed to between the parties;

7.7.1.2 A mutually accepted lump sum, properly itemized and supported by sufficient substantiating data to permit evaluation by the District;

7.7.1.3 Costs, fees and any other markups set forth in the Agreement; or

7.7.1.4 If an increase or decrease cannot be agreed to as set forth in items 7.7.1.1 through 7.7.1.3 above and the District issues a DAP, the cost of the change of the Work shall be determined by the actual cost or savings in the performance of the Work resulting from the change, including a reasonable markup for overhead and profit, as may be set forth or limited in the Agreement.

7.7.2 If unit prices are set forth in the Contract Documents or are subsequently agreed to by the parties, but application of such unit prices will cause substantial inequity to the District or Contractor because of differences in the character or quantity of such unit items as originally contemplated, such unit prices shall be equitably adjusted.

7.7.3 Negotiations over changes in the Contract Price will be conducted using an open-book cost-estimating process. The District defines “open-book” to include all elements of Contractor’s costs, including labor hours and rates, units and estimated quantities, unit prices, equipment estimates, material costs, and subcontractor costs. Contractor shall openly share its detailed cost estimate, material and subcontractor quotations and any other information used to compile its cost estimate.

7.7.4 If the District and Contractor disagree upon whether Contractor is entitled to be paid for any services required by the District, or if there are any other disagreements over the scope of Work or proposed changes to the Work, the District and Contractor shall resolve the disagreement pursuant to Section 8 hereof.

7.8 Emergencies.

7.8.1 In any emergency affecting the safety of persons and/or property, Contractor shall act, at its discretion, to prevent threatened damage, injury or loss. Any change in the Contract Price and/or Contract Times on account of emergency work shall be determined as provided in this Section 7.

8.0 Claims and Claim Resolution

8.1 Claims.

8.1.1 “**Claim**” means a demand or assertion by one of the parties to the Agreement seeking, as a matter of right, adjustment of contract terms, payment of money, extension of time, or other relief with respect to the terms of the Contract Documents. The term “Claim” also includes other disputes between the District and the Contractor arising out of or relating to the Contract Documents. Claims must be made by written notice. The responsibility to substantiate claims rests with the party making the claim.

8.1.2 Claims by Contractor must be made within twenty-one (21) days after occurrence of the event giving rise to the Claim or within twenty-one (21) days after the Contractor first recognizes, or reasonably should have recognized, the condition giving rise to the Claim, whichever is later. An additional Claim made after the initial Claim has been resolved will not be considered unless submitted in a timely manner.

8.1.3 Pending final resolution of a Claim, including litigation, unless otherwise directed by the District in writing, Contractor shall proceed diligently with performance of the Work and the District shall continue to make payments in accordance with the Contract Documents.

8.2 Claim Resolution.

8.2.1 The parties shall attempt in good faith to resolve promptly through negotiation any Claim or dispute arising out of or relating to this Contract. If a dispute or Claim should arise, the District’s Project Director and Contractor’s Project Manager will meet at least once to attempt to resolve the dispute. For such purpose, either may request the other to meet within seven (7) days of the date the Claim is made, at a mutually agreed upon time and place.

8.2.2 If the District’s Project Director and Contractor’s Project Manager are not able to resolve the dispute within fourteen (14) days after their first meeting (or such longer period of time as may be mutually agreed upon), either party may request that the District’s Senior Representative and the Contractor’s Senior Representative meet at least once to attempt to resolve the dispute.

8.2.3 If the Claim or dispute has not been resolved within sixty (60) days of the date the Claim is made, either party may refer the Claim or dispute to non-binding mediation by sending a written mediation request to the other party. In the event that such a request is made, the Parties agree to participate in the mediation process. Non-binding mediation of claims or controversies under this Contract shall be conducted by a professional mediator that is mutually acceptable to and agreed upon by both parties (the “Mediator”). The parties and the Mediator may join in the mediation any other party necessary for a mutually acceptable resolution of the dispute. The mediation procedure shall be determined by the Mediator in consultation with the parties. The fees and expenses of the Mediator shall be borne equally by the parties.

8.2.4 If the Claim or dispute is not resolved within thirty (30) days after the commencement of mediation, or if no mediation has been commenced within one hundred and twenty (120) days of the date the Claim is made, either party may commence litigation to resolve the dispute, in accordance with the Contract Documents.

9.0 Suspension and Termination

9.1 The District's Right to Suspend Work.

9.1.1 The District may, without cause and for its convenience, order Contractor in writing to stop and suspend the Work.

9.1.2 Contractor is entitled to seek an adjustment of the Contract Price and/or Contract Times if its cost or time to perform the Work has been adversely impacted by any suspension or stoppage of the Work by the District.

9.2 The District's Right to Terminate for Convenience.

9.2.1 Upon ten (10) days' written notice to Contractor, the District may, for its convenience and without cause, elect to terminate this Agreement. In such event, the District shall pay Contractor for the following:

9.2.1.1 All Work executed and for proven loss, cost or expense in connection with the Work;

9.2.1.2 The reasonable costs and expenses attributable to such termination, including demobilization costs and amounts due in settlement of terminated contracts with subcontractors and consultants; and

9.2.1.3 The fair and reasonable sums for overhead and profit on the sum of items 9.2.1.1 and 9.2.1.2 above.

9.3 The District's Right to Perform and Terminate for Cause.

9.3.1 If Contractor fails to (i) provide a sufficient number of skilled workers, (ii) supply the equipment, materials, or supplies required by the Contract Documents, (iii) comply with applicable Legal Requirements, (iv) timely pay, without cause, consultants or subcontractors, (v) prosecute the Work with promptness and diligence to ensure that the Work is completed by the Contract Times, as such times may be adjusted, or (vi) perform the Work in accordance with the Contract Documents, then the District, in addition to any other rights and remedies provided in the Contract Documents or by law, shall have the rights set forth in Sections 9.3.2 and 9.3.3 below.

9.3.2 Upon the occurrence of an event set forth in Section 9.3.1 above, the District may provide written notice to Contractor that it intends to terminate the Agreement unless the problem cited is cured, or commenced to be cured, within ten (10) days of Contractor's receipt of such notice. If Contractor fails to cure, or reasonably commence to cure, such problem, then the District may declare the Agreement terminated for default by providing written notice to Contractor of such declaration.

9.3.3 Upon declaring the Agreement terminated pursuant to Section 9.3.2 above, the District may enter upon the premises and take possession, for the purpose of completing the Work, of all materials, equipment, scaffolds, tools, appliances and other items thereon, which have been purchased or provided for the performance of the Work, all of which Contractor hereby transfers, assigns and sets over to the District for such purpose, and to employ any person or persons to complete the Work and provide all of the required labor, services, materials, equipment and other items. In the event of such termination, Contractor shall not be entitled to receive any further payments under the Contract Documents until the Work shall be finally completed in accordance with the Contract Documents. At such time, if the unpaid balance of the Contract Price exceeds the cost and expense incurred by the District in completing the Work, such excess shall be paid by the District to Contractor. If the District's cost and expense of completing the Work exceeds the unpaid balance of the Contract Price, then Contractor shall pay the difference to the District. Such costs and expenses include not only the cost of completing the Work, but also losses, damages, costs and expenses, including attorneys' fees and expenses, incurred by the District in connection with the repurchase and defense of claims arising from Contractor's default.

9.3.4 If the District improperly terminates the Agreement for cause, the termination for cause will be converted to a termination for convenience in accordance with the provisions of Section 9.2 above.

9.4 Contractor's Right to Stop Work.

9.4.1 Contractor may, in addition to any other rights afforded under the Contract Documents or at law, stop the Work for the District's failure to timely pay amounts properly due under Contractor's Application for Payment.

9.4.2 If the District fails to timely pay amounts properly due to Contractor, Contractor may provide the District with written notice that Contractor will stop the Work unless payment is made within thirty (30) Days from the District's receipt of Contractor's notice. If the District does not cure the problem within such thirty (30) Day period, Contractor may stop the Work. In such case, Contractor shall be entitled to make a claim for adjustment to the Contract Price and Contract Times to the extent it has been adversely impacted by such stoppage.

9.5 Contractor's Right to Terminate for Cause.

9.5.1 Contractor, in addition to any other rights and remedies provided in the Contract Documents or by law, may terminate the Agreement for cause for the following reasons:

9.5.1.1 The Work has been stopped for one hundred and twenty (120) consecutive Days, or more than two hundred and forty (240) Days in the aggregate during the duration of the Project, because of court order, any government authority having jurisdiction over the Work, or orders by the District under Section 9.1.1 hereof, provided that such stoppages are not due to the acts or omissions of Contractor or anyone for whose acts Contractor may be responsible.

9.5.1.2 The District's failure to provide Contractor with any information, permits or approvals that are the District's responsibility under the Contract Documents which result in the Work being stopped for one hundred and twenty (120) consecutive Days, or more than two hundred and forty (240) Days in the aggregate during duration of the Project, even though the District has not ordered Contractor in writing to stop and suspend the Work pursuant to Section 9.1.1 hereof.

9.5.1.3 The District's continued failure to cure a non-payment after Contractor has stopped the Work in accordance with Section 9.4.2, above.

9.5.2 Upon the occurrence of an event set forth in Section 9.5.1 above, Contractor may provide written notice to the District that it intends to terminate the Agreement unless the problem cited is cured, or commenced to be cured, within twenty-one (21) Days of the District's receipt of such notice. If the District fails to cure, or reasonably commence to cure, such problem, then Contractor may give a second written notice to the District of its intent to terminate within an additional seven (7) Day period. If the District, within such second seven (7) Day period, fails to cure, or reasonably commence to cure, such problem, then Contractor may declare the Agreement terminated for default by providing written notice to the District of such declaration. In such case, Contractor shall be entitled to recover in the same manner as if the District had terminated the Agreement for its convenience under Section 9.2 of the Agreement.

9.6 Bankruptcy of Contractor.

9.6.1 If Contractor institutes or has instituted against it a case under the United States Bankruptcy Code, or any equivalent law of another country, such event may impair or frustrate the Contractor's ability to perform its obligations under the Contract Documents. Accordingly, should such event occur:

9.6.1.1 Contractor, its trustee or other successor, shall furnish, upon request of the District, adequate assurance of the ability of the Contractor to perform all future material obligations under the Contract Documents, which assurances shall be provided within ten (10) days after receiving notice of the request; and

9.6.1.2 Contractor shall file an appropriate action within the bankruptcy court to seek assumption or rejection of the Agreement within sixty (60) days of the institution of the bankruptcy filing and shall diligently prosecute such action. If Contractor fails to comply with its foregoing obligations, the District shall be entitled to request the bankruptcy court to reject the Agreement, declare the Agreement terminated and pursue any other recourse available to the District under this Section 9, specifically including termination for cause.

9.6.2 The rights and remedies under Section 9.6.1 above shall not be deemed to limit the ability of the District to seek any other rights and remedies provided by the Contract Documents or by law, including its ability to seek relief from any automatic stays under the United States Bankruptcy Code.

10.0 Miscellaneous

10.1 Confidential Information.

10.1.1 “**Confidential Information**” means information that is determined by the transmitting party to be of a confidential or proprietary nature and: (i) the transmitting party identifies as either confidential or proprietary; (ii) the transmitting party takes steps to maintain the confidential or proprietary nature of the information; and (iii) the document is not otherwise available in or considered to be in the public domain. The receiving party shall maintain the confidentiality of the Confidential Information and shall use the Confidential Information solely in connection with the Project.

10.2 Prohibited Interest.

10.2.1 No member, officer, agent, or employee of the District during his or her tenure or for one year thereafter shall have any interest, direct or indirect, including prospective employment by, Contractor or the proceeds under this Contract without specific written authorization by the District.

10.3 No Publicity.

10.3.1 Contractor shall not make any disclosure or publicize in any way its Work on the Project, or disclosure any information about the District or the Site, without the express written consent of the District.

10.4 Assignment.

10.4.1 Contractor acknowledges that the Work to be performed by Contractor is considered personal by the District. Contractor shall not assign or transfer its interest in this

Contract without prior written approval by the District. Any attempt to assign or transfer Contractor's interest in this Contract without prior written approval by the District will be void.

10.5 Successorship.

10.5.1 Contractor and the District intend that the provisions of the Contract Documents are binding upon the parties, their employees, agents, heirs, successors and permitted assigns.

10.6 Governing Law.

10.6.1 The Agreement and all Contract Documents are governed by the laws of the State of Utah, without giving effect to its conflict of law principles. Actions to enforce the terms of this Agreement may only be brought in the Third District Court for Salt Lake County, Utah, or the Federal District Court for the District of Utah, in Salt Lake City, Utah.

10.7 Governmental Immunity.

10.7.1 The District does not, by entering into this Contract, waive any protections afforded by the Governmental Immunity Act of Utah, Utah Code Ann. § 63G-7-101 *et seq.*

10.8 Severability.

10.8.1 If any provision or any part of a provision of the Contract Documents is finally determined to be superseded, invalid, illegal, or otherwise unenforceable pursuant to any applicable Legal Requirements, such determination shall not impair or otherwise affect the validity, legality, or enforceability of the remaining provision or parts of the provision of the Contract Documents, which shall remain in full force and effect as if the unenforceable provision or part were deleted.

10.9 No Waiver.

10.9.1 The failure of either Contractor or the District to insist, in any one or more instances, on the performance of any of the obligations required by the other under the Contract Documents shall not be construed as a waiver or relinquishment of such obligation or right with respect to future performance.

10.10 Headings.

10.10.1 The headings used in these General Conditions of Contract, or any other Contract Document, are for ease of reference only and shall not in any way be construed to limit or alter the meaning of any provision.

10.11 Amendments.

10.11.1 The Contract Documents may not be changed, altered, or amended in any way except in writing signed by a duly authorized representative of each party.

Exhibit B
Supplemental Conditions

[To be negotiated prior to contract execution, if necessary]

Exhibit C

Insurance Requirements

1. During the term of the Contract, Contractor shall maintain at its own expense, and provide proof of said insurance to the District, the following types of insurance:
 - i. General Liability Insurance: Commercial general liability insurance on an occurrence basis arising out of claims for bodily injury (including death) and property damage. Such insurance shall provide coverage for ongoing operations and products-completed operations, blanket contractual, broad form property damage, personal and advertising injury, independent contractors and sudden and accidental pollution liability [pollution liability arising out of a hostile fire] with a \$3,000,000 minimum per occurrence limit combined bodily injury and property damage, with a \$3,000,000 minimum aggregate limit, provided the general policy aggregate shall apply separately to the Contractor on a per project basis. Any aggregate limit that does not apply separately to the premises shall be at least double the required per occurrence limit.
 - ii. Automobile insurance covering owned, if any, non-owned, and hired automobile with limits not less than \$1,000,000 combined single limit of coverage.
 - iii. Workers' Compensation Insurance: Statutory workers' compensation insurance (Part A). Such insurance shall also include employer's liability (Part B) insurance in a limit of no less than \$1,000,000 for each: accident, disease, employee. No owner or officer may be excluded.
 - iv. Builder's Risk / Installation Floater: Contractor shall provide optional terms for builder's risk and/or installation floater insurance. Contractor agrees to have the District approve builder's risk / installation floater insurance program including limits, deductibles, terms, etc. The District shall maintain the right to obtain and implement builder's risk / installation floater coverage at their discretion.
2. Additional Insured Endorsements: All policies of liability insurance required to be maintained by the Contractor shall be endorsed to name the District as additional insured for ongoing operations (ISO CG 20 10 or equivalent) and completed operations (ISO CG 20 37 or equivalent).

3. Primary and Non-Contributory Endorsements: The Contractor's insurance coverage shall be a primary insurance as respects to the District, its officers, officials, employees and volunteers. Any insurance or self-insurance maintained by the District, its officers, officials, and employees shall be in excess of the contracting party's insurance and shall not contribute with it.
4. Waiver of Subrogation Endorsements: The Contractor hereby waives any and every claim for recovery from the District, its officers, officials, and employees for any and all loss or damage covered by any of the insurance policies to be maintained under this Contractor agreement to the extent that such loss or damage is recovered under any such policy. To the extent the foregoing waiver would preclude coverage under any insurance required by this Section, the Contractor shall give written notice of the terms of such waiver to each insurance company which has issued, or which may issue in the future, any such policy of insurance (if such notice is required by the insurance policy) and shall cause each such insurance policy to be properly endorsed, or to otherwise contain one or more provisions that prevent the invalidation of the insurance coverage by reason of such a waiver.
5. Contractor states that this Agreement has been thoroughly reviewed by its insurance agent, broker or consultant, and that said agent/broker/ consultant has been instructed to procure for Contractor the insurance coverage and endorsements required herein.

NORTH VILLAGE SPECIAL SERVICE DISTRICT

Invitation for Bids

Part E – Forms

PRICE FORM
NVSSD Coyote Lane Sewer Lift Station

Bid Schedule A – Coyote Lane Sewer Lift Station

Item No.	Description	Qty	Units	Unit Price	Total Price
A1	Mobilization	1	LS		\$
A2	Materials Testing	1	LS		\$
A3	Construction Surveying	1	LS		\$
A4	Traffic Control	1	LS		\$
A5	Site Clearing / Excavation / Backfill	1	LS		\$
A6	Lift Station Building	1	LS		\$
A7	Lift Station Internal Piping and Pumps	1	LS		\$
A8	Electrical / HVAC / SCADA	1	LS		\$
A9	Site Piping (includes 8" force main and connecting 15" gravity sewer to junction manhole east of lift station)	1	LS		\$
A10	Site Improvements	1	LS		\$
A11	6' Tall Black Vinyl Chain Link Fence and Gate	326	LF	\$	\$
Subtotal Schedule A Amount					\$

PRICE FORM
NVSSD Coyote Lane Sewer Lift Station

Bid Schedule B – Gravity Sewer Pipelines for Coyote Lane Sewer Lift Station

Item No.	Description	Qty	Units	Unit Price	Total Price
B1	Mobilization	1	LS		\$
B2	Materials Testing	1	LS		\$
B3	Construction Surveying	1	LS		\$
B4	Traffic Control	1	LS		\$
B5	New 15" PVC Sewer (Sta. 0+00 to 7+23 along Hwy 40)	708	LF	\$	\$
B6	New 15" PVC Sewer	128	LF	\$	\$
B7	New 8" PVC Sewer	504	LF	\$	\$
B8	Modify Existing Sewer Manhole Along Hwy 40	3	Each	\$	\$
B9	New 5' Dia Sewer Manhole	3	Each	\$	\$
B10	New 4' Dia Sewer Manhole	2	Each	\$	\$
B11	Abandon Existing Sewer Manhole	2	Each	\$	\$
Subtotal Schedule B Amount					

PRICE FORM
NVSSD Coyote Lane Sewer Lift Station

Additive Alternate Bid Schedule

Item No.	Description	Qty	Units	Unit Price	Total Price
Alt 1	Dewatering for Lift Station Construction (0-50 gpm)	1	LS		\$
Alt 2	Dewatering for Sewer Pipeline Construction	708	LF	\$	\$
Alt 3	Foundation Stabilization Material for Pipeline Trench (2" Sewer Rock)	70	CY	\$	\$
Subtotal Additive Alternate Amount					

Total Amount of Schedule A, B and Additive Alternate	\$

Company Name: _____

Authorized Signature: _____

Date: _____

Receipt of Addenda:

Addendum #1 _____

Addendum #2 _____

INFORMATION REQUIRED OF BIDDERS

Coyote Lane Sewer Lift Station

The BIDDER shall furnish the following information on the following form. Failure to comply with this requirement, misrepresent or provide inaccurate information will render the BID informal and may cause its rejection. Additional sheets shall be attached as required.

- (1) Contractor's name and address:

- (2) Contractor's telephone number: _____.

- (3) Contractor's license: Primary Classification:_____.

State License No.: _____ Supplemental

Classification held, if any: _____.

Bid Limit: _____.

- (4) Number of years as a contractor in construction work of this type under the present firm name:

_____ years.

- (5) List of subcontractors and suppliers for this project:

INFORMATION REQUIRED OF BIDDERS

Coyote Lane Sewer Lift Station

- (6) Complete this form by listing all construction contracts completed by the Contractor during the last 3 years involving work of similar type and comparable value.

- **Name of project:** _____

- Names, address and telephone number of the owner:

- Name, address and telephone number of the engineer or architect:

- Location of project: _____

- Contract amount: _____

- Brief description of the work involved: _____

- **Name of project:** _____

- Names, address and telephone number of the owner:

- Name, address and telephone number of the engineer or architect:

- Location of project: _____

- Contract amount: _____

- Brief description of the work involved: _____

INFORMATION REQUIRED OF BIDDERS

Coyote Lane Sewer Lift Station

- **Name of project:** _____
- Names, address and telephone number of the owner:

- Name, address and telephone number of the engineer or architect:

- Location of project: _____
- Contract amount: _____
- Brief description of the work involved: _____

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**SECTION 01 10 00
SUMMARY OF WORK**

PART 1 GENERAL

1.1 GENERAL

- A. The work to be performed under this project shall consist of furnishing all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the plans Drawings and as herein specified.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Work includes construction of a sewer lift station including two 20HP dry pit submersible chopper sewer pumps and all related piping, site work and appurtenances and approx. 1,352' of 8" and 15" PVC gravity sewer lines.

1.3 CONTRACTOR USE OF PREMISES

- A. CONTRACTOR's use of the project site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities.

1.4 PROJECT SECURITY

- A. CONTRACTOR shall make all necessary provisions to protect the project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

1.5 CHANGES IN THE WORK

- A. It is mutually understood that it is inherent in the nature of public works construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to unforeseen field conditions, and that it is of the essence of the Contract to recognize a normal and expected margin of change. ENGINEER shall have the right to make such changes, from time to time, in the plans, in the character of the work, and in the scope of the project as may be necessary or desirable to ensure the completion of the work in the most satisfactory manner without invalidating the Contract.

END OF SECTION

SECTION 01 10 25 MEASUREMENT AND PAYMENT

1.1 GENERAL

- A.** All work completed under this contract shall be in accordance with the Plans and Specifications and will be measured by ENGINEER/OWNER. The quantities appearing on the Bid Schedule are approximate only, and are prepared for the comparison of bids. Payment to CONTRACTOR on bid items with unit prices other than "Lump Sum" will be made for actual quantities of work performed and accepted, or material furnished in accordance with the Contract. The scheduled quantities of work to be done and materials to be furnished may be increased or decreased.
- B.** The term "Lump Sum" when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure, portion of work, or unit is specified "Lump Sum" as the unit of measurement, the unit will include fittings, accessories, and all work necessary to complete the work as shown on the plans and as specified.
- C.** When the accepted quantities of work vary from the quantities in the bid schedule, CONTRACTOR shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the work done. OWNER reserves the right to add to or delete from quantities listed in the bid schedule in order to match the total bid with the budgeted money available.

1.2 BID SCHEDULE

A. BID ITEM A1 and B1 - MOBILIZATION

- 1. **GENERAL** This bid item is provided to cover CONTRACTOR's cost for general and miscellaneous responsibilities and operations not normally attributed to any other single bid item within this schedule. This shall include, but is not limited to, work described or enumerated in Section 01 71 13 - Mobilization.
- 2. **METHOD OF MEASUREMENT** Lump Sum
- 3. **BASIS OF PAYMENT** Includes all preparatory work and operations, including, but not limited to, those necessary for movement of personnel, equipment, supplies and incidental items to the project site; for establishment of all offices, buildings and other facilities necessary for work on the project; for cleanup and demobilization as required; and for all other work and operations which must be performed, or costs incurred, not otherwise paid for prior to beginning work on various items on the project site.

B. BID ITEM A2 and B2 - MATERIALS TESTING

1. **GENERAL** This item is provided to cover the Contractor's cost for general and miscellaneous responsibilities and operations associated with Materials Testing. This item shall include, but is not limited to, work described in Section 01452, Testing Agency Services and Section 01 45 00, Quality Control and Materials Testing.
2. **METHOD OF MEASUREMENT** Lump Sum
3. **BASIS OF PAYMENT** Payment will be made at the contract lump sum bid price as shown and accepted by the Owner and Engineer in the Bid Schedule. Payments will be made in accordance with the following schedule:
 - a) When 10% of the original contract amount is earned, 25% of the amount bid for materials testing will be paid.
 - b) When 25% of the original contract amount is earned, an additional 25% for a total of 50% of the amount bid for materials testing will be paid.
 - c) When 50% of the original contract amount is earned, an additional 25% for a total of 75% of the amount bid for materials testing will be paid.
 - d) When 75% of the original contract amount is earned, an additional 25% for a total of 100% of the amount bid for materials testing will be paid.

C. BID ITEM A3 and B3 - CONSTRUCTION SURVEYING

1. **GENERAL** This item is provided to cover the Contractor's cost for general and miscellaneous responsibilities and operations associated with Construction Surveying, which shall be performed by a registered professional land surveyor.
2. **METHOD OF MEASUREMENT** Construction Surveying shall be measured based on the percentage of work completed for the project according to the amount defined in the Bid Schedule.

D. BID ITEM A4 and B4 – TRAFFIC CONTROL

1. **GENERAL** This bid item is provided to cover CONTRACTOR's cost for traffic control and shall include, but is not limited to, work described in Section 01 55 26.
2. **METHOD OF MEASUREMENT** Payment will be made at the contract lump sum bid price. Payment covers all costs associated with all labor, materials and equipment required to develop and implement a traffic control plan in accordance with the requirements of Owner and UDOT; maintain smooth vehicular traffic flow in the project area during construction. Payment includes but not limited to:

signage, electronic message boards, barriers, warning devices, flaggers, public notification, and cleaning of roads to maintain a clean condition with no accumulation of dirt, debris, or other foreign objects as required by the contract and the street cut permits. Payment shall also include all labor materials, and equipment required to maintain safe pedestrian access through the project area during construction; including but not limited to signage, warning devices, safety fencing, and maintaining a clean sidewalk that is free of dirt, gravel, and other construction debris.

E. BID ITEM A5 – SITE CLEARING / EXCAVATION / BACKFILL

1. **METHOD OF MEASUREMENT** Lump Sum
2. **BASIS OF PAYMENT** Payment covers removal, transport, disposal, applicable dumping fees, cleanup of waste materials, and related costs for all unwanted material from the surface and subsurface within the project limits such as trees, vegetation, boulders, stumps, roots, buried logs, and other debris.
3. Payment covers all cost of preparing the site for construction in accordance with project specifications and drawings including but not limited to addressing any erosion control measures set forth in the erosion control plan in order to control storm water runoff on the site and prevent sediment flows off of the project site; furnish and install construction fencing and any other miscellaneous tasks necessary to prepare the site for construction including all materials, equipment, and labor required to perform the work.
4. Payment covers excavation of the site to specified grades per the construction drawings and includes excavation, any necessary shoring and bracing, the stockpiling of materials in a manner which does not create an obstruction to construction activities or a safety hazard, and any other costs associated with site excavation per the construction drawings and specifications including all materials, equipment, labor required to perform the work and to dispose of any excess material off-site.
5. Payment covers all cost of backfilling structure and final grading of entire project site including but not limited to the cost of placing, compacting, screening of material and finish grading for all fill as shown on the drawings and according to required specifications including all materials, equipment, and labor required to perform the work.

F. BID ITEM A6 – LIFT STATION BUILDING

1. **METHOD OF MEASUREMENT** Lump Sum.
2. **BASIS OF PAYMENT** Payment covers all labor, material and equipment including, but not limited to importing and compaction of structural fill, building

foundation, installing all reinforced concrete, carpentry, roofing, hatches, doors, grating, railings, hoist crane, painting, concrete equipment pads, piping through walls/ceiling, insulation and miscellaneous items to complete the structure of the lift station.

G. BID ITEM A7 – LIFT STATION INTERNAL PIPING AND PUMPS

1. **METHOD OF MEASUREMENT** Lump Sum
2. **BASIS OF PAYMENT** Payment shall be considered complete compensation for all labor, equipment, and materials, including but not limited to pumps, valves, fittings, gauges, flow meter, and all internal piping as indicated on the drawings, pressure testing; painting, and all other items required to complete the project.

H. BID ITEM A8 – ELECTRICAL / HVAC / SCADA

1. **METHOD OF MEASUREMENT** Lump Sum
2. **BASIS OF PAYMENT** Payment shall be made at the contract unit lump sum bid price for completion of all electrical, HVAC and SCADA work as shown on the drawings and specified herein. Payment shall include furnishing and installing all electrical, HVAC and SCADA equipment, including but not limited to motor control centers, panels, electrical service, devices, equipment, wire and conduit, instrumentation, pressure switches and transmitters, lightning protection system, security, lighting, unit heaters, air handling units, exhaust fans, ducting, louvers and all other related items as shown on the drawings not paid elsewhere.

Payment also includes installation of the owner-furnished gas backup generator and transfer switch.

Payment also includes connecting to the existing gas line and extending the gas service to the new lift station building and backup generator as shown on the Drawings and in accordance with all Dominion Energy requirements and specifications.

I. BID ITEM A9 - SITE PIPING

1. **METHOD OF MEASUREMENT** Lump Sum
2. **BASIS OF PAYMENT** Payment shall be at the contract lump sum price bid for the cost of furnishing and installing all piping and fittings as shown on the drawings and found within the specifications and not included in construction of the lift station. This includes the cost of all incidental work such as: potholing, piping, bends, fittings, couplings, joint lubricants, thrust blocks and other joint restraints, nuts, bolts and washers, selective clearing, removal, and disposal of interfering structures and obstructions; excavation, trench shoring or trench boxes as

applicable, all pipe zone and trench backfill materials; backfill, removal and disposal of waste materials, restoration of all utilities damaged as a result of operations; and similar work to complete the installation of the site piping.

Payment covers the 8" PVC force main and connection to the existing 8" force main as shown on the Drawings.

Payment covers installation of the 15" PVC gravity sewer lines connecting the wet well and junction manhole at Sta. 8+60 as shown on the Drawings.

J. BID ITEM A10 - SITE IMPROVEMENTS

1. **METHOD OF MEASUREMENT** Lump Sum
2. **BASIS OF PAYMENT** Payment covers all cost of final grading of entire project site including but not limited to the cost of placing, compacting, screening of material and finish grading for all fill as shown on the drawings and according to required specifications including all materials, equipment, and labor required to perform the work.

Payment covers construction of asphalt access road and parking area, concrete sidewalk on the east side of the lift station, bollards on the east side of the wet well, landscaping gravel and all other site improvements as shown on the Drawings.

K. BID ITEM A11 - 6' TALL BLACK VINYL CHAIN LINK FENCE AND GATE

1. **METHOD OF MEASUREMENT** Lineal Foot
2. **BASIS OF PAYMENT** Includes cost for all required earthwork; concrete work for post footings; furnishing and installing fence posts, fabric, tension wires, and all appurtenant items; furnishing and installing gates, as indicated; and all appurtenant work.

**L. BID ITEM B5 – NEW 15" PVC SEWER (STA. 0+00 TO 7+23 ALONG HWY 40)
BID ITEM B6 – NEW 15" PVC SEWER
BID ITEM B7 – NEW 8" PVC SEWER**

1. **METHOD OF MEASUREMENT** Lineal Foot (does not include length through manholes).
2. **BASIS OF PAYMENT** Includes all labor, equipment, and materials necessary, including but not limited to connection to existing pipe; furnishing the PVC pipe, temporary bypass piping and pumping; excavation, removal and disposal of excavated materials, shoring, installing the pipe, marking tape and tracer wire, bedding with import Pipe Zone, native Trench Backfill material, backfilling, compaction, restoration of all surface improvements, cleaning, testing, and placing

pipelines into service and all other operations and materials required to complete a functioning pipeline as herein described and as shown on the drawings.

M. BID ITEM B8 – MODIFY EXISTING SEWER MANHOLE ALONG HWY 40

1. **METHOD OF MEASUREMENT** Per each modified sewer manhole
2. **BASIS OF PAYMENT** Includes all labor, equipment, and materials, including but not limited to excavation, bypass pumping, core existing manhole, connection of pipe to manhole, shoring, forming a new concrete trough, backfilling existing manhole up to new invert elevation, backfilling, compaction, restoration of all surface improvements and other operations and materials required to complete the item in accordance with the drawings and specifications.

**N. BID ITEM B9 – NEW 5’ DIA. SEWER MANHOLE
BID ITEM B10 – NEW 4’ DIA. SEWER MANHOLE**

1. **METHOD OF MEASUREMENT** Per each sewer manhole
2. **BASIS OF PAYMENT** Includes all labor, equipment, and materials, including but not limited to excavation, temporary bypass piping and pumping, connection of pipes to manhole, shoring, concrete, installation, removal and disposal of excess excavated materials, backfilling, compaction, ring and cover, restoration of all surface improvements and other operations and materials required to complete the item in accordance with the plans and specifications.

O. BID ITEM NO. B11 - “ABANDON EXISTING SEWER MANHOLE”

1. **METHOD OF MEASUREMENT** Per each abandoned sewer manhole.
2. **BASIS OF PAYMENT** Payment for this item shall be paid for at the contract unit price per each abandoned sewer manhole accepted in place and shall be full compensation for all labor, equipment, and materials required to complete the item including but not limited to excavation, removal of required portions of the manhole, backfilling with select native material, compaction, protection of existing utilities, removal and disposal of excess materials, coordination, restoration of all surface improvements and all other operations and materials required to complete the item in accordance with the plans and technical specifications.

P. BID ITEM ALT 1 – DEWATERING FOR LIFT STATION (0-50 GPM)

1. **METHOD OF MEASUREMENT** Lump Sum.
2. **BASIS OF PAYMENT** Payment covers all dewatering including all labor, equipment, and materials, including but not limited to, excavation, pumping, dewatering, shoring, backfilling, and other operations and materials required to

complete the dewatering of the work site. Contractor to assume the necessary site excavation can be dewatered pumping a flow up to 50 gpm.

Q. BID ITEM ALT 2 – DEWATERING FOR SEWER PIPELINE CONSTRUCTION

1. **METHOD OF MEASUREMENT** Lineal Foot.
2. **BASIS OF PAYMENT** Payment covers all dewatering including all labor, equipment, and materials, including but not limited to pumping, dewatering, shoring, and other operations and materials required to complete the dewatering of the trench for installation of the sewer pipeline.

R. BID ITEM ALT 3 – FOUNDATION STABILIZATION MATERIAL FOR PIPELINE TRENCH (2" SEWER ROCK)

1. **METHOD OF MEASUREMENT** Cubic Yard installed as directed by OWNER. CONTRACTOR shall provide weigh tickets showing cubic yards of material placed to OWNER for quantity verification.
2. **BASIS OF PAYMENT** Payment covers all labor, equipment and materials including but not limited to pipeline stabilization material conforming to the specifications, storage, handling, placement, compaction, removal and disposal of all unacceptable native materials and all other operations, materials and incidentals required to complete this item as shown on the drawings and specified herein.

- END OF SECTION -

SECTION 01 14 13
SITE ACCESS

PART 1 HIGHWAY LIMITATIONS

- A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the work. It shall be the Contractor's responsibility to construct, maintain and restore, at his own expense, any haul roads or staging areas required for his construction operations.

PART 2 TEMPORARY ACCESS

- A. General. Wherever necessary or required for the convenience of the public or individual residents at street or highway crossings, private driveways, or elsewhere, the Contractor shall provide suitable temporary bridges over unfilled excavations, except in such cases as the Contractor shall secure the written consent of the individuals or authorities concerned to omit such temporary bridges, which written consent shall be delivered to the Engineer prior to excavation. All such bridges shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the Contractor shall adopt designs furnished by said authority for such bridges, or shall submit designs to said authority having jurisdiction in each case, and the Contractor shall adopt designs furnished by said authority for such bridges, or shall submit designs to said authority for approval, as may be required.
- B. Street Use. Nothing herein shall be construed to entitled the Contractor to the exclusive use of any public street, alley, way, or parking area during the performance of the work hereunder, and he shall so conduct his operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleys, ways, or parking areas. No street shall be closed to the public without first obtaining permission of the Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise provided or shown. Toe boards shall be provided to retain excavated material if required by the Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the Contractor to assure the use of sidewalks and the proper functioning of all gutters, sewer inlets, and other drainage facilities.

- D. Street Closure. If closure of any street is required during construction, a formal application for a street closure shall be made to the authority having jurisdiction at least 30 days prior to the required street closure in order to determine necessary signing and detour requirements.
- E. Construction Through Private Property. The Owner will provide easement agreements with private property owners along the construction routes.

The Contractor shall confine all his operation to the area within the easement limits. In general, the easement area is intended to provide reasonable access and working area for efficient operation by the Contractor.

If the Contractor desires to have additional easement width and/or additional access routes, the Contractor shall negotiate with and compensate the private property owners for such use at the Contractor's expense.

END OF SECTION 01 14 13

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- B. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.
- C. OWNER, and/or utility owners may be working within the project area while this contract is in progress. If so, CONTRACTOR shall schedule his work in conjunction with these other organizations to minimize mutual interference.
- D. If required to work in City or County streets or Utah Department of Transportation (UDOT) right-of-way, CONTRACTOR shall notify City, County, or UDOT 72 hours prior to work being performed therein. Work within the City or County streets or UDOT right-of-way shall be in accordance with their required permits and any license agreements with OWNER. CONTRACTOR shall obtain and comply with all required permits.

1.2 FIELD ENGINEERING

- A. Contractor shall provide all construction staking as necessary to complete the required work according to the Contract Documents.
- B. Locate and protect survey control and reference points. Promptly notify ENGINEER of discrepancies discovered.
- C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- D. Promptly report to ENGINEER loss or destruction of reference point or relocation required because of changes in grades or other reasons.

1.3 PRECONSTRUCTION MEETING

- A. Prior to the commencement of work at the site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by CONTRACTOR's Project Manager, its superintendent, and its subcontractors as appropriate. Other attendees will be:
 - 1. ENGINEER and the Resident Project Representative (RPR),
 - 2. Representatives of OWNER,

3. Governmental representatives as appropriate, and
 4. Others as requested by CONTRACTOR, OWNER, or ENGINEER.
- B. Unless previously submitted to ENGINEER, CONTRACTOR shall bring to the conference one copy of each of the following:
1. Progress schedule,
 2. Procurement schedule of major equipment and materials and items requiring long lead time, and
 3. Shop Drawings/Sample/Substitute or "Or Equal" submittal schedule.
- C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include the following:
1. CONTRACTOR's tentative schedules.
 2. Transmittal, review, and distribution of CONTRACTOR's submittals.
 3. Processing applications for payment.
 4. Maintaining record documents.
 5. Critical work sequencing.
 6. Field decisions and Change Orders.
 7. Use of project site, office and storage areas, security, housekeeping, and OWNER's needs.
 8. Major equipment deliveries and priorities.
 9. CONTRACTOR's assignments for safety and first aid.

1.4 PROGRESS MEETINGS

- A. CONTRACTOR shall schedule and hold regular on-site progress meetings at least bi-weekly and at other times as required by ENGINEER or as required by progress of the work. CONTRACTOR, ENGINEER, and all subcontractors active on the site shall be represented at each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers', and other subcontractors.

- B. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.
- C. At each construction progress meeting a progress report shall be presented by the CONTRACTOR containing an updated Progress Schedule. Where the delayed completion date of a project phase is noted, the CONTRACTOR shall describe the anticipated delays or problems and outline the action plan being taken to resolve the issues.

- END OF SECTION -

SECTION 01 33 00
SUBMITTAL PROCEDURES

GENERAL

1.1 SUBMITTAL PROCEDURES

- A. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- B. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- C. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
- D. Schedule submittals to expedite Project, and deliver to Engineer at business address. Coordinate submission of related items.
- E. Submittals shall be submitted sufficiently in advance to allow the ENGINEER not less than ten regular working days for examining the drawings. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the contract drawings and/or specifications.
- F. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- G. When revised for resubmission, identify changes made since previous submission.
- H. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- I. Submittals not requested will not be recognized or processed.
- J. The ENGINEER's review of CONTRACTOR submittals shall not relieve CONTRACTOR of the entire responsibility for the corrections of details and dimensions. CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in CONTRACTOR submittals. CONTRACTOR shall be responsible for dimensions and the design of adequate connections and details.

1.2 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial schedules within 30 days after date of Owner-Contractor Agreement. After review, resubmit required revised data within ten days.
- B. Submit revised Progress Schedules with each Application for Payment.
- C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.
- D. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.
- E. Submit computer generated horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.
- F. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.
- G. Indicate estimated percentage of completion for each item of Work at each submission.
- H. Submit separate schedule of submittal dates for shop drawings, product data, and samples.

1.3 PRODUCT DATA

- A. Product Data: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

1.4 SHOP DRAWINGS

- A. Shop Drawings: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Fabrication of an item may be commenced only after the ENGINEER has reviewed the pertinent submittals and returned copies to CONTRACTOR marked either "Approved", or "Approved - Except as Noted". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

- C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
 - 1. Include signed and sealed calculations to support design.
 - 2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 - 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- D. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 78 50 - Project Closeout.

1.5 SAMPLES

- A. Whenever indicated in the specifications or requested by the ENGINEER, CONTRACTOR shall submit at least 1 sample of each item or material to the ENGINEER for acceptance at no additional cost to OWNER.
- B. Samples, as required herein, shall be submitted for acceptance prior to ordering such material for delivery to the jobsite, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delay in the Work.
- C. Unless otherwise specified, all colors and textures of specified items will be selected by the ENGINEER from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.6 CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Engineer, in quantities specified for Product Data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.

1.7 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.8 MANUFACTURER'S FIELD REPORTS

- A. When required in individual sections, have manufacturer or Supplier provide qualified representative to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable and to make written report of observations and recommendations to ENGINEER.

PRODUCTS - Not Used

EXECUTION - Not Used

END OF SECTION

**SECTION 01 35 00
SAFETY AND SITE GUIDELINES**

PART 1 GENERAL

1.1 CONSTRUCTION AREA PLAN

- A. Construction activities are to be limited to within limits of disturbance as per plans or elements with the exception of access drives and utility improvements.

1.2 OSHA COMPLIANCE

- A. All applicable Occupational Safety and Health Act (OSHA) regulations and guidelines are to be observed at all times.

1.3 ACCESS TO CONSTRUCTION AREA

- A. Access during construction of the meter vault, pump station or other improvements is to be approved by the OWNER in accordance with the following requirements:
 - 1. All Construction Vehicles are to be identified with the Contractor's name.
 - 2. Material and equipment deliveries are to be consolidated to the extent feasible.

1.4 CONSTRUCTION PARKING AREAS

- A. All vehicle and parking areas are to be managed in accordance with the following requirements:
 - 1. Construction crews are not to park on, or otherwise use, the natural area, streets, and neighboring properties. All vehicles are to be parked in approved parking areas.
 - 2. During busy construction periods involving multiple trades when all Construction Vehicles cannot be accommodated on the site, the OWNER may grant permission for overflow vehicles to temporarily park in designated areas.
 - 3. Vehicles parked on the road may not impede access to normal traffic and emergency vehicles, including fire trucks. Where parking on the shoulder occurs, all damage to the shoulder and landscape is to be repaired by the CONTRACTOR continually and not left for the end of construction. Vehicles may not be parked outside of the Construction Area.
 - 4. No vehicle repair is allowed on the site except in case of emergency or within a fully-enclosed garage. Normal maintenance of CONTRACTOR equipment is allowed.

1.5 DELIVERY AND STORAGE OF MATERIALS & EQUIPMENT

- A. CONTRACTOR is responsible for ensuring all SUBCONTRACTORS and SUPPLIERS obey all posted speed limits and traffic regulations. The following, additional Guidelines apply to all material delivery and storage:
 - 1. All building materials, equipment and machinery are to be delivered to and remain within the limits of disturbance. This requirement includes all building materials, earth-moving equipment, trailers, generators, mixers, cranes and any other equipment or machinery that will remain on the Construction Site overnight.
 - 2. Delivery vehicles may not drive across neighboring properties to access a construction site.
 - 3. Delivery route maps and site supervisor contact information sheets are to be provided to all delivery personnel.
 - 4. Delivery personnel are to use adequate winter tires and/or chains during inclement winter weather.

1.6 SITE VISITATIONS

- A. Due to the inherent danger associated with Construction Activities, visitors to any Construction Site are limited to those persons (such as construction workers, tradesmen, County or City agents, security staff and OWNER staff) with official business relating to the construction. Construction personnel are not to invite or bring family members or friends, especially children, to the job site.

1.7 FIRE AND SAFETY PRECAUTIONS

- A. The following fire and safety precautions are to be adhered to at all Construction Sites:
 - 1. On-site fires are not allowed.
 - 2. All fires are to be reported even if it is thought to be contained or extinguished.
 - 3. One or more persons are to be appointed as the individual(s) responsible for reporting emergencies and/or phoning 911.
 - 4. Access for emergency vehicles is to be maintained at all times.
 - 5. Access to fire hydrants, emergency water tanks and emergency turnouts are not to be blocked at any time.
 - 6. Smoking materials are to be discarded in approved containers.
 - 7. A minimum of one shovel and two 20-pound ABC-Rated Dry Chemical Fire Extinguishers are to be mounted in plain view.
 - 8. All equipment, including small tools, must utilize a working spark arrestor.

PART 2 EQUIPMENT

2.1 CONSTRUCTION TRAILERS AND/OR TEMPORARY STRUCTURES

- A. Upon approval, a temporary construction trailer or portable field office may be located on the project site within limits of disturbance,

2.2 SANITARY FACILITIES

- A. CONTRACTOR is responsible for providing adequate sanitary facilities for construction workers. Portable toilets are to be located within the limits of disturbance and are not to be located within 50 feet of drainages and/or other sensitive resources.

2.3 DEBRIS AND WASTE REMOVAL

- A. The following debris and waste removal procedures are to be adhered to at all Construction Sites:
 - 1. Dumping, burying and/or burning trash is not permitted anywhere within the Project Site. No trash of any kind is to be placed in utility trenches.
 - 2. Heavy and large debris, such as broken stone and wood scraps, are to be removed from the site immediately upon completion of each work trade.
 - 3. Concrete washout, from both trucks and mixers, is to be contained within the limits of disturbance and concealed by structure or covered with backfill. Concrete washout in road rights-of-way, setbacks or on neighboring properties is strictly prohibited.
 - 4. Dirt, mud and/or other debris are to be promptly removed from public or private roads, open spaces, and driveways. Trucks and other equipment are to be washed clean of dirt and other debris prior to leaving the site.

2.4 HAZARDOUS WASTE

- A. In order to monitor hazardous material use and/or respond quickly to spills, the CONTRACTOR is to comply with the following criteria:
 - 1. The CONTRACTOR is to provide a contact person and telephone number for a company experienced in emergency response for vacuuming and containing spills for oil or other petroleum products.
 - 2. In the event of a spill, the CONTRACTOR is to immediately attempt to stop the flow of contaminants.
 - 3. Absorbent sheets are to be used for spill prevention and clean up. Several boxes are to be located at fuel trucks, storage areas and in maintenance vehicles. Inventories are to be maintained as necessary.
 - 4. The responsible on-site CONTRACTOR is to commit all necessary manpower, equipment and materials to the containment and rapid clean-up of spills.

5. After any reportable spill (one or more gallons) is contained; the CONTRACTOR is to notify the appropriate local, state and federal agencies as well as the OWNER.
6. The CONTRACTOR is to maintain a list of product names and a Materials Safety Data Sheet (MSDS) for all hazardous material products used or located on-site. In the event of a leak, spill or release, the CONTRACTOR is to provide the MSDS to emergency personnel.
7. Equipment is to be fueled in designated staging areas only. Equipment that cannot be readily moved to designated staging areas is to be fueled a minimum of 100 feet from known drainage courses.
8. Fuel storage tanks must have adequately constructed catch basins.
9. Prior to storing a hazardous material, the CONTRACTOR is to ensure that:
 - The material is stored in an approved container
 - The container is tightly sealed
 - The container has the proper warning label
 - The container is inspected for leaks
10. Inspect equipment and vehicles for damaged hoses, leaks and hazards prior to the start and end of each shift. Do not run equipment that is leaking hazardous products.
11. Intentional or unreported spillage or dumping of fuels, hydraulics, solvents and other hazardous materials will be cause for eviction.

2.5 TREE/SHRUB AND HABITAT PROTECTION

- A. The following Guidelines apply to the protection of trees, shrubs and other vegetation during construction operations:
 1. Trees/shrubs are not to be removed without prior approval from the OWNER.
 2. Before construction starts, exclusionary fencing is to be installed around the perimeter of all trees/shrubs not approved for removal.
 3. Fencing material is to be highly visible and sturdy.
 4. Construction equipment or activity is not permitted within the fenced area (exclusionary zone) without written authorization from the OWNER.
 5. Adequate drainage is to be provided to prevent ponding of water around the base of trees/shrubs.
 6. Soil compaction is to be avoided around all trees/shrubs.
 7. Mesh netting is to be used to protect trees/shrubs from dust and paint drift.

2.6 AIR QUALITY CONTROL

- A. Air quality control procedures are to be in accordance with the following requirements:
 1. Construction equipment exhaust emissions are not to exceed local code requirements for air pollution limitations.
 2. Open burning of removed vegetation is not permitted.

2.7 DAMAGE, REPAIR AND RESTORATION

- A. Damage and scarring to other property, including streets, neighboring properties, existing buildings, roads, driveways and/or other Improvements will not be permitted. If any such damage occurs, it is to be repaired and/or restored promptly at the expense of the person causing the damage or the CONTRACTOR whose personnel or subcontractor caused the damage.
 - 1. Upon completion of construction, each OWNER and CONTRACTOR is to clean his Construction Site and any neighboring sites that have been impacted and repair all property, which has been damaged.
 - 2. The CONTRACTOR is financially responsible for site restoration/revegetation and refuse removal necessitated on any and all adjacent properties as a result of trespass or negligence by their employees or sub-contracted agents.

2.8 FIREARMS

- A. The possession or discharge of any type of firearm by construction personnel anywhere within the Project Site is prohibited.

PART 3 EXECUTION

3.1 ALCOHOL AND CONTROLLED SUBSTANCES

- A. The consumption of alcohol or use of any controlled substance by construction personnel anywhere within the project is prohibited.

3.2 NO PETS

- A. No pets may be brought to the project site by construction personnel.

3.3 NOISE CONTROL

- A. The CONTRACTOR is to make every effort to keep noise to a minimum. Radios and other audio equipment may not be audible beyond the confines of the Construction Site. Violations of this provision will precipitate a total prohibition of any radios and/or other audio equipment.

3.4 SPEED LIMIT

- A. All vehicles are to adhere to posted speed limits. Fines will be issued for those exceeding the speed limit as posted or as required by road and weather conditions.

END OF SECTION 01 35 00

SECTION 01 45 00
QUALITY CONTROL AND MATERIALS TESTING

PART 1 GENERAL

1.1 MATERIALS

- A. All materials incorporated in the project shall be new and shall fully comply with the specifications. Unless otherwise clearly provided in the specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by the contract are to be of the best available grade of their respective kinds. Whenever, in the specifications, any material, article, device, product, fixture, form, type of construction, or process indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired and shall be deemed to be followed by the words "or approved equal" and CONTRACTOR may in such case, upon receiving the ENGINEER's approval, purchase and use any item, type, or process which shall be substantially equal in every respect to that indicated or specified.
- B. Materials and equipment may be used in the Work based upon receipt of a Supplier's certificate of compliance. Certificate must be in possession of CONTRACTOR and reviewed by ENGINEER prior to use.
- C. Quality Assurance Testing by the OWNER and/or ENGINEER shall not relieve CONTRACTOR of responsibility to furnish materials and work in full compliance with Contract Documents.

1.2 MANUFACTURER'S INSTRUCTIONS

- A. Should instructions conflict with Contract Documents, request clarification before proceeding.
- B. When required in individual sections, submit manufacturer's instructions in the quantity required for product data, delivery, handling, storage, assembly, installation, start-up, adjusting, balancing, and finishing, as appropriate.

1.3 WORKMANSHIP

- A. Maintain performance control and supervision over Subcontractors, Suppliers, manufacturer's, products, services, workmanship, and site conditions, to produce work in accordance with Contract Documents.
- B. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

- C. Provide suitable qualified personnel to produce specified quality.
- D. Ensure finishes match approved samples.

1.4 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.5 TESTING AND INSPECTION SERVICES

- A. Testing agency and testing for quality control and material testing shall be furnished by CONTRACTOR as part of the project. Results of testing shall be reported to CONTRACTOR and ENGINEER on site. Reports of the testing shall be transmitted directly to the ENGINEER.
- B. Materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the work by the testing agency. CONTRACTOR shall give ENGINEER written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin so ENGINEER may witness testing by the testing agency. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude retesting or re-inspection at the site of the work.
- C. CONTRACTOR shall furnish such samples of materials as are requested by the ENGINEER, without charge. No material shall be used until reports from the testing agency have been reviewed and accepted by the ENGINEER.

1.6 UNSATISFACTORY CONDITIONS

- A. Examine areas and conditions under which materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

1.7 QUALITY CONTROL TESTING

- A. ENGINEER's failure to detect any defective Work or materials does not prevent later rejection when such defect is discovered nor does it obligate ENGINEER for acceptance.

- B. CONTRACTOR shall provide 24-hours minimum notice to ENGINEER for all testing required by these specifications so that ENGINEER may coordinate or be present during testing.

1.8 TESTING ACCEPTANCE AND FREQUENCY

- A. Minimum Quality Control Testing Frequency: As defined in Table 01 45 00-1, the CONTRACTOR shall be responsible to ensure that all testing is performed at the frequencies shown. CONTRACTOR shall uncover any work at no cost to OWNER to allow the testing agency to perform required testing at the frequency shown.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

TABLE 01 45 00-1: QUALITY CONTROL TESTING FREQUENCY

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
SUBGRADE AND BACKFILL MATERIALS		
Section 33 05 20 Trenching	Field Density	1 test per 200 linear feet per lift. Lift thickness before compaction – 8 inches for other than hand operated compactors, and 6 inches for hand operated compactors.
	Laboratory	1 test for each material type which includes proctor, classification and gradation.
Section 31 23 23 Backfill	Field Density	1 test for each 1.5 feet of backfill thickness.
	Laboratory	1 test for each material type which includes proctor, classification and gradation.
ASPHALT		
Section 32 12 16 Hot-Mix Asphalt Concrete Paving		<u>Marshall Test Method</u> : 1 test initially per each type of material and each change in target, and for each day of production thereafter.
	Mix Design	<u>Specific Gravity</u> : 1 per each Marshall Test <u>Extraction</u> : 1 test per each Marshall Test
	Field Density	<u>Bituminous surfaces</u> : 1 test per 2,000 square feet placed or part thereof.
	Asphalt Thickness and Core Density	<u>Bituminous surfaces</u> : 1 test sample every 300 linear feet of completed roadway
PORTLAND CEMENT CONCRETE		
Cast-in-Place Concrete	Slump	1 test every day of placement or 1 test for every 50 cubic yards and more frequently if batching appears inconsistent. Conduct with strength tests.
	Entrained air	1 test with slump test.
	Ambient and concrete tem- peratures	1 test with slump test.
	Water cement ratio.	to be verified and provided with batch tickets.

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
	Compressive strength	1 set of 4 cylinders every 50 c.y. or part thereof per day.
NOTES: 1 Additional tests shall be conducted when variations occur due to the contractor's operations, weather conditions, site conditions, etc. 2 Classification, moisture content, Atterberg limits and specific gravity tests shall be conducted for each compaction test if applicable. 3 Tests can substitute for same tests required under "Aggregates" (from bins or source), although gradations will be required when blending aggregates. 4 Aggregate moisture tests are to be conducted in conjunction with concrete strength tests for water/cement calculations.		

END OF SECTION

SECTION 01 45 10
TESTING AGENCY SERVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. CONTRACTOR shall be responsible for providing Construction Quality Control Testing of all soils, concrete, etc. as required by the various sections of these specifications.
- B. This section includes the following:
 - 1. Use of independent testing agency.
 - 2. Control testing report submittal requirements.
 - 3. Responsibilities of testing agency.

1.2 REFERENCES

- A. ASTM D 3740: Standard Recommended Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- B. ASTM D 4561: Standard Practice for Quality Control Systems for and Inspection and Testing Agency for Bituminous Paving Materials.
- C. ASTM E 329: Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

1.3 DEFINITIONS

- A. Independent Testing Agency: A testing agency NOT owned by CONTRACTOR, and an agency that does not have any preferential affiliation or association with CONTRACTOR, or any of CONTRACTOR's Subcontractors and Suppliers other than entering into a contract with CONTRACTOR to perform the duties defined in these specifications.
- B. Professional Engineer: An engineer who complies with Utah licensing law and is acceptable to the authority having jurisdiction.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall employ and pay for, all material testing services as described in Paragraph 1.1 A, through an independent testing agency which complies with ASTM D 3740, ASTM D 4561, and ASTM E 329 to test materials for contract compliance.
- B. Concrete Technician: Approved by ENGINEER or ACI certified.

1.5 CONTRACTOR SUBMITTALS

- A. Prior to start of Work, submit testing agency's name, address, telephone number and the following:
 - 1. Person charged with engineering managerial responsibility.
 - 2. Professional engineer on staff to review services.
 - 3. Level of certification of technicians.

1.6 TESTING AGENCY SUBMITTALS

- A. Field Test Report: Submit report no later than the end of the current day.
- B. Laboratory Test Report: Submit original report within 48 hours after test results are determined.
- C. Final Summary Report: Submit prior to final payment.
- D. On all reports include:
 - 1. Project title, number and date of the report.
 - 2. Date, time and location of test
 - 3. Name and address of material Supplier.
 - 4. Identification of product being tested and type of test performed.
 - 5. Identify whether test is initial test or retest.
 - 6. Results of testing and interpretation of results.
 - 7. Name of technician who performed the testing.

1.7 RESPONSIBILITIES OF TESTING AGENCY

- A. Calibrate testing equipment at least annually with devices of an accuracy traceable to either National Bureau of Standards or acceptable values of natural physical constraints.
- B. Provide sufficient personnel at site and cooperate with CONTRACTOR, ENGINEER and OWNER's Representative in performance of testing service.
- C. Secure samples using procedures specified in the applicable testing code.
- D. Perform testing of products in accordance with applicable sections of the Contract Documents.
- E. Immediately report any compliance or noncompliance of materials and mixes to CONTRACTOR, ENGINEER and OWNER's Representative.

- F. When an out-of-tolerance condition exists, perform additional inspections and testing until the specified tolerance is attained, and identify retesting on test reports.
- G. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by Engineer. Payment for re-testing or re-inspection will be paid for by Contractor.

1.8 LIMITS ON TESTING AGENCY AUTHORITY

- A. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
- B. Agency may not suspend Work.
- C. Agency may not assume duties of Contractor.
- D. Agency has no authority to accept Work for OWNER.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 50 00 TEMPORARY CONTROLS

1.01 SITE MAINTENANCE

The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

2.01 DISPOSAL OF WASTE MATERIAL

When burning is not prohibited or restricted by law, pile all combustible material within the designated or approved cleared area and dispose of by burning. Remove material from the site which is not combustible or not practicable to burn. Accomplish burning and disposal in accordance with all Federal, State and local laws relating to fire prevention, air pollution control, and other restrictions in regard to burning materials. When burning is prohibited, dispose of waste materials in accordance with the governing agency safety and health requirements.

If perishable material is burned, it shall be burned under the constant care of competent watchmen at such times and in such a manner that anything designated to remain on the property, or other adjacent property will not be jeopardized. Burning shall be done in accordance with applicable laws and ordinances.

3.01 "NO BURNING" PERIODS

During periods when burning operations are prohibited by local, State or Federal authorities, haul combustible material and debris from the site. If approved, pile where it will not interfere with the work, and burn when prohibition against burning is removed.

4.01 AIR POLLUTION CONTROL

The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

5.01 NOISE CONTROL

The Contractor shall conform to all local, state and federal noise control ordinances

6.01 DUST ABATEMENT

The Contractor shall furnish all labor, equipment, and means required and shall carry out effective measures wherever, whenever and as often as necessary to prevent his operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity. The Contractor shall conform to all local, state and federal dust abatement ordinances. The Contractor shall be responsible for any damage resulting from any dust originating from his operations. The dust abatement measures shall be continued until the Contractor is relieved of further responsibility by the Engineer. No separate payment will be allowed for dust abatement measures and all costs thereof shall be included in the Contractor's bid price.

7.01 RUBBISH CONTROL

During the progress of the work, the Contractor shall keep the site of the work and other areas used by him in a neat and clean condition, and free from any accumulation of rubbish. The Contractor shall dispose of all rubbish and waste materials of any nature occurring at the work site, and shall establish regular intervals of collection and disposal of such materials and waste. He shall also keep his haul roads free from dirt, rubbish, and unnecessary obstructions resulting from his operations. Equipment and material storage shall be confined to areas approved by the Engineer. Disposal of all rubbish and surplus materials shall be off the site of construction, at the Contractor's expense, all in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the particular requirements of Subpart H, Section 1926.252 of the OSHA Safety and Health Standards for Construction.

8.01 SANITATION

- A. Toilet Facilities. Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction.
- B. Sanitary and Other Organic Wastes. The Contractor shall establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the site in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto. Disposal of all such wastes shall be at the Contractor's expense.

9.01 CHEMICALS

All chemicals used during project construction or furnished for project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, reactant or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be strict accordance with the printed instructions of the manufacturer.

10.01 EROSION CONTROL

Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas to prevent erosion and sedimentation. Periodically inspect earthwork to detect any evidence of the start of erosion, apply corrective measures as required to control erosion.

Furnish material and construct temporary erosion control including berms, dikes, sediment basins, slope drains, check dams, sediment barriers, fiber mats, mulches, etc. The Engineer may direct the Contractor to install additional erosion controls if, in the opinion of the Engineer, the risk of potential erosion is not adequately addressed. Coordinate temporary control measures with permanent erosion control requirements.

- A. Do not start grading work until installation of all temporary erosion control measures is complete.
- B. Complete installation of all erosion control in a timely manner.
- C. Do not pollute streams, canals, lakes, and other water courses. Use the erosion control measures indicated.
- D. Follow the more restrictive requirements when conflicts occur between erosion control specifications and federal, state, or local agencies laws, rules, or regulations.

11.01 FAILURE TO EXECUTE

Failure to execute any of the temporary controls shall be sufficient cause for the Owner to stop forward progression of the work and hold progress payments until acceptable limits and standards are met.

12.01 FIRE SUPPRESSION PLAN

The Contractor shall be required to maintain adequate equipment, manpower and water sources available to extinguish any fires which may be started, directly or indirectly, through activities of the Contractor.

13.01 SMOKING

Due to a substantial risk of wildfires, smoking shall be restricted to occur only inside of enclosed equipment or other designated area. During times of higher fire danger, the local authority may place additional restrictions on smoking in the canyon area.

14.01 COSTS

All costs in connection with the work specified herein will be considered to be incidental to the project.

END OF SECTION 01 50 00

SECTION 01 52 00
CONSTRUCTION FACILITIES

1.01 GENERAL

The Contractor shall set up construction facilities in a neat and orderly manner. The Contractor shall be responsible for providing the site to establish the temporary construction facilities, where not specifically provided for in the Contract.

2.01 SECURITY

The Contractor shall at all times provide such permanent and temporary fencing as may be necessary to restrict unauthorized entry to the site. Contractor shall abide by the Owner's security requirements.

3.01 CONTRACTOR'S EQUIPMENT

- A. General. It shall be the Contractor's responsibility to provide equipment that is adequate for the performance of the work under this Contract within the time specified. All equipment shall be kept in satisfactory operating condition, shall be capable of safely and efficiently performing the required work, and shall be subject to inspection and approval by the Engineer at any time within the duration of the Contract. All work hereunder shall conform to the applicable requirements of the OSHA Standards for Construction.
- B. Separate Contracts. Whenever portions of the work hereunder are let under separate contracts, all of the provisions of this Section shall apply to each such prime contractor, including the requirements for separate field offices and communications facilities.
- C. Construction Lighting. All work conducted at night or under conditions of deficient daylight shall be suitably lighted to insure proper work and to afford adequate facilities for inspection and safe working conditions.

4.01 UTILITIES

- A. Water Supply. All drinking water on the site during construction shall be furnished by the Contractor.
- B. Water Connections. The Contractor shall not make connection to, or draw water from, any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the Contractor shall first attach to the fire hydrant or pipeline a valve and a meter, if required by said authority, of a size and type acceptable to said authority and agency.

- C. Removal of Water Connections. Before final acceptance of the work on the project, all temporary connections and piping installed by the Contractor shall be entirely removed, and all affected improvements shall be restored to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.
- D. Power. The Contractor shall provide, at his own expense, all necessary power required for his operations under the Contract, and shall provide and maintain all temporary power lines required to perform the work in a safe and satisfactory manner. Temporary electric power installation shall meet the construction safety requirements of OSHA, State and other governing agencies.
- E. Approval of Electrical Connections. All temporary connections for electricity shall be subject to approval of the Engineer and the power company representative, and shall be removed in like manner at the Contractor's expense prior to final acceptance of the work.
- F. Communication. Contractor shall provide his own telephone or communication system at the site as required to complete the project.

5.01 SAFETY

- A. General. Appropriate first aid facilities and supplies shall be kept and maintained by the Contractor at the site of the work. All persons within the construction area shall be required to wear protective helmets, protective eye wear as required, and steel toed safety shoes. In addition, all employees of the Contractor and his subcontractors shall be provided with, and required to use, personal protective and life saving equipment as set forth in Subpart E of the OSHA Safety and Health Standards for Construction (29 CFR 1926).
- B. Public Safety. During the performance of the work the Contractor shall erect and maintain temporary fences, bridges, railings, and barriers and shall take all other necessary precautions and place proper guards for the prevention of accidents and he shall erect and maintain suitable and sufficient lights and other signals.

6.01 PROJECT SIGN

No project sign is required.

7.01 SANITARY FACILITIES

The Contractor shall provide and maintain sanitary facilities (toilet and wash-up facilities) for his employees and his subcontractors' employees that will comply with the regulations of the local and State Departments of Health and as directed by the Engineer.

8.01 STORAGE OF MATERIALS

Materials shall be so stored as to insure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, they shall be placed on wooden platforms or other hard, clean surfaces, and not on the ground. Delicate instruments and materials subject to vandalism shall be placed under locked cover and, if necessary, provided with temperature control as recommended by the manufacturer. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without the written permission of the Owner or lessee.

END OF SECTION 01 52 00

SECTION 01 55 26 TRAFFIC CONTROL

PART 1 - GENERAL

1.01 SCOPE

The Contractor shall be responsible for the safety of traffic within the project limits and on the approaches to the project. The Contractor shall furnish, erect, and maintain such warning signs, lights, and devices as are necessary to protect the public, and the Construction Manager may point out inadequacies of such warning devices. However, the Contractor shall not be relieved of his responsibility to protect the public by an approval given by the Construction Manager or by the Construction Manager's failure to point out any deficiency.

All signs, barricades, delineators, and other traffic control devices used for the detouring or routing of traffic in, around, and through the construction area, shall conform to Utah Department of Transportation standards. Barricades and delineators shall be maintained so that the reflective materials are clean and visible at all times during hours of darkness.

The Contractor shall develop in detail and submit to UDOT and the Construction Manager for approval of his plans that involve the interruption, restriction, or detouring of traffic. Plans shall be submitted for each separate case at least 10 days before the proposed involvement with traffic. As a minimum, plans shall state location, type of involvement, hours per day, time of day, types of barricades and warning devices, and number and location of flagmen.

PART 2 - EXECUTION

2.01 TRAFFIC CONTROL AND SITE PROTECTION

At all times, traffic shall be controlled by pavement markings or channelization devices. As a minimum, pavement markings shall consist of 4-inch by 8-inch reflectorized pavement markers at 25-foot spacings. All inappropriate pavement markings shall be satisfactorily obliterated prior to the shifting of traffic. Obliteration by painting over existing paint will not be satisfactory.

Traffic shall be maintained through all intersections at all times. Access to all existing side roads, businesses, parking lots, and residences shall be provided at all times throughout the project. When access must be temporarily blocked for any length of time, the Contractor must give advance notification and obtain approval from the Construction Manager.

During non-working hours, the Contractor shall place all materials and parked equipment within approved barricaded work zones. The Contractor will park and store materials in designated parking areas only. Vehicles and materials will not be allowed to be parked along the streets or highway during working hours or during non working hours. These restrictions will also apply to the storing of materials, the parking of equipment which is not being used, and workmen's vehicles.

2.02 STRIPPING

All temporary striping and marking as required for traffic control by the Utah Department of Transportation, shall be installed, maintained, and removed by the Contractor. Permanent roadway, walkway, and bikeway stripes and markers on public rights-of-way shall be replaced by the Contractor. Stripes and markers on private property shall be replaced by the Contractor at his expense.

2.03 SIGNS

The protection and maintenance of existing signs and the removal, protection, storage, and resetting of local, municipal, or state traffic signs that are affected by the work shall be the responsibility of the Contractor. Damaged or lost signs shall be replaced and paid for by the Contractor. Traffic signs and traffic control facilities existing within the limits of the project shall not be moved except as necessary to prevent them from being damaged by construction operations.

Traffic signs and traffic control facilities existing on the project that are necessary for the control of traffic during the project, such as stop signs, shall be maintained in place in an upright position and located so as to properly control traffic. Whenever it is necessary to remove them from their permanent location due to construction work, they shall be placed in a temporary location to properly control traffic and shall be reinstalled in their permanent location at the earliest possible time.

All traffic signs and traffic control facilities existing on the project that are not necessary for control of traffic during construction and which will be needed after completion of the project shall be removed and stockpiled and reinstalled in their permanent location at the earliest possible time.

END OF SECTION 01 55 26

SECTION 01 64 00
OWNER FURNISHED PRODUCTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. OWNER and CONTRACTOR responsibilities for the 70kW Natural Gas Generator and Transfer Switch furnished by the OWNER.

1.2 RELATED SECTIONS

- A. Section 26 32 13 – Engine Generators
- B. Section 26 36 00 – Transfer Switches

1.3 OWNER'S RESPONSIBILITIES

- A. Once delivered, inspect generator and transfer switch jointly with CONTRACTOR.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Once delivered, inspect generator and transfer switch jointly with ENGINEER/OWNER, record damaged or defective items.
- B. CONTRACTOR shall take possession of the natural gas generator and transfer switch and be responsible for delivery to the project site.
- C. CONTRACTOR's Insurance shall provide coverage for OWNER furnished items effective until final acceptance of the project by the OWNER.
- D. Handle products at site, including loading, unloading, and storage.
- E. Protect product from damage.

1.5 CONSTRUCTION DELAY

- A. If OWNER furnished items may cause delay in the critical path of progress schedule notify ENGINEER in writing. Only changes to the critical path will be evidence as changes in the Contract Time.

- END OF SECTION -

SECTION 01 71 13
MOBILIZATION

PART 1 GENERAL

- A. This specification covers the following:
1. Organization and mobilization of Contractor's forces and equipment; and
 2. Transporting various tools, materials, and equipment to the site.
- B. Temporary Facilities and other mobilization items are specified in the General Conditions and in various sections under Division 1 and 2. Payment, however, will be included under mobilization.

PART 2 DESCRIPTION

- A. Mobilization shall include mobilization of all construction equipment, materials, supplies, appurtenances, and the like, manned and ready for commencing and prosecuting the work; and the subsequent demobilization and removal from the site of said equipment, appurtenances and the like upon completion of the work.
- B. Mobilization shall also include assembly and delivery, to the project site, of equipment, materials, and supplies necessary for the prosecution of work but which are not intended to be incorporated in the work; the clearing of and preparation of the Contractor's work area; the complete assembly, in working order, of equipment necessary to perform the required work; personnel services preparatory to commencing actual work; and all other preparatory work required to permit commencement of the actual work on the construction items for which payment is provided for under the contract.

END OF SECTION 01 71 13

**SECTION 01 75 00
STARTUP PROCEDURES**

PART 1 GENERAL

1.1 DESCRIPTION

- A. Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 - Submittals:

1. Test reports shall be submitted in accordance with paragraphs entitled, "Factory Tests", "Functional Test", and "Final Acceptance Test" of this section.
2. Test procedures and the recording forms shall be submitted according to paragraph entitled, "Test Procedures."

B. Tests Required

1. Tests shall be performed to verify proper functioning of HVAC, electrical switchgear, telemetry, pump/motor combinations, hydraulic and pneumatic control, condition/performance monitoring systems, energy control and monitoring systems, and other assemblies and components that need to be tested as an integrated whole.

C. Factory Tests

1. Tests shall be performed at the factory to verify proper build. These test results will be used in the "Final Acceptance Test" section to verify no shipping damage and proper installation.

D. Functional Test

1. Contractor shall perform "in-house" tests to verify that the systems and components have been properly installed and are functioning properly. Tests shall be performed in the presence of the Project Representative. Test shall be completed and found acceptable when system has performed per other sections and referenced industry standards.

E. Final Acceptance Test

1. Contractor shall perform a formal test with full documentation using the approved recording form. Project Representative will witness this test and issue a written

final acceptance. Final test data shall be provided to the Project Representative. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

F. Test Procedures

1. Test procedure and recording forms that document the test steps shall be submitted for approval to the Project Representative 21 calendar days prior to the proposed test date. Procedure shall consist of step-by-step instruction to verify system parameters, components, and functions.

1.3 COMMISSIONING

- A. After completion of all testing, the Contractor shall make written application to the Project Representative for permission to demonstrate compliance of the equipment, structures, and systems furnished and installed under this contract with all requirements of the Project Manual. Such application shall be furnished to the Project Representative not less than 21 days prior to startup of completed portions of the facility. Upon receipt of written permission from the Project Representative, and on the agreed upon date, the Contractor shall do all things necessary to permit adequate operation of the facilities.
- B. The Contractor shall allow for a commissioning period as set forth in Part 3 to satisfy the Project Representative that the contract requirements have been fulfilled. The commissioning period may be broken into several segments comprising complete systems at the discretion of the Project Representative.
- C. During the commissioning period, the Owner will provide staff for operation and maintenance of the facility. The Contractor shall provide/coordinate other Contractor personnel including equipment manufacturer service representatives for troubleshooting, training of Owner personnel, or repair and maintenance of equipment within the terms of the contract. Contractor provided personnel for troubleshooting, repair or maintenance of equipment shall be provided as soon as possible and in no case longer than 8 hours after notification from the Contractor's coordinator. Such coordinators shall be familiar with the facility equipment and operations and shall be acceptable to the Project Representative. "Coordinator service" shall mean attendance at the site for whatever period is required at whatever time necessary in response to a request from the Project Representative.
- D. The Owner will pay for all electrical power, and water for operation of the facility during commissioning.
- E. In the event that permanent power is not yet available to the pump station, Contractor shall be responsible for providing power for the testing of the pumps and all other

electrical component.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 FINAL ACCEPTANCE

- A. The duration of the Final Acceptance Test shall be 3 days. During that period, the Contractor shall demonstrate the operation of all equipment and all systems installed under this contract. Commissioning period shall commence from the date of substantial completion.

END OF SECTION

**SECTION 03 10 00
CONCRETE FORMWORK**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included - Provide formwork in accordance with the provisions of this Section for all cast-in-place concrete shown on the Drawings or required by other Sections of these Specifications.

1.02 QUALITY ASSURANCE

- A. Design of formwork - Is the Contractor's responsibility.
- B. Standards - Comply with all pertinent provisions of the ACI 347.
- C. Qualifications of workmen: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed, the referenced standards, and the requirements of this work, and who shall direct all work performed under this Section.

1.03 SUBMITTALS

- A. Manufacturers' data - Within 30 calendar days after award of the Contract, submit manufacturers' data and installation instructions for proprietary materials, including form coatings, ties and accessories, and manufactured form systems if used.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Forms
1. Construct formwork for exposed (painted or unpainted) concrete surfaces with smooth faced undamaged plywood or other panel type materials acceptable to the Engineer, to provide continuous, straight, smooth as-cast surfaces. Furnish in largest practicable sizes to minimize number of joints for "non-architectural" concrete finish.
 2. Construct formwork for concrete concealed from view or covered with cement plaster with rough sawn boards of sound grade, as approved by the Engineer, to provide a mechanical bond for subsequent application of plaster.

3. Provide for material with sufficient thickness to withstand pressure of newly placed concrete without excessive and objectionable bow or deflection.
4. Concrete Column Forms: Sonoco products company regular "Sonotube" fiber forms or equal. Provide in one piece per column.

B. Form Ties

1. Provide factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.
2. Provide ties so that portion remaining within concrete after removal of exterior parts is at least 3.8 cm (1.5") from the outer concrete surface. Provide form ties which will not leave a hole larger than 2.5 cm (1") diameter in the concrete surface.

C. Form Coatings - Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

2.02 DESIGN OF FORMWORK

A. General

1. Design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure.
2. Carry vertical and lateral loads to ground by formwork system and in-place construction that has attained adequate strength for the purpose.
3. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
4. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
5. Provide shore and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof.
6. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

7. Support form facing materials by structural members spaced sufficiently close to prevent objectionable deflection.
8. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities, and within allowable tolerances.
9. Provide camber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads.
10. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

B. Earth Forms

Side forms of footings may be omitted and concrete placed directly against excavation only when requested by the Contractor and accepted by the Engineer. When omission of forms is accepted, provide additional concrete 2.5 cm (1") on each side of the minimum design profiles and dimensions shown.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

Examine the substrate and conditions under which work of this Section is to be performed, and correct unsatisfactory conditions which would prevent proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 FORM CONSTRUCTION

A. General

1. Construct forms complying with ACI 347, to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grades, level, and plumb work in finish structures.
2. Provide for openings, offsets, sinkages, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bullheads, anchorages, inserts, and other features required. Use selected materials to obtain required finishes.
3. Forms for openings, and construction which accommodates installation by other trades whose materials and products must be fabricated before the opportunity exists to verify the measurements of adjacent construction which affects such installations, shall be accurately sized and located as dimensioned on the Drawings. In the event that deviation from the Drawing dimensions results in problems in the field, the Contractor shall be responsible for resolution of the conditions as approved by the Engineer, without additional expense to the Owner.

B. Fabrication

1. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways- reglets, recesses, and the like, to prevent swelling and assure ease of removal.
2. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to temporary openings on forms in as inconspicuous locations as possible, consistent with design requirements. Form intersecting planes to provide true, clean cut corners.

C. Falsework

1. Erect falsework and support, brace and maintain it to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place construction. Construct falsework so that adjustments can be made for take-up and settlement.
2. Provide wedges, jacks, or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce Work of required dimensions.

D. Forms for Exposed Concrete

1. Drill forms to suite ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.
2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
3. Use extra studs, walers, and bracing to prevent objectionable bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.
4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

- E. Corner Treatment - Unless shown otherwise, form chamfers with 2 cm x 2 cm (3/4" x 3/4") strips, accurately formed and surfaced to produce uniformly straight lines and tight edge joints on exposed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
- F. Control Joints - Locate as indicated
- G. Provision for Other Trades - Provide openings in concrete formwork to accommodate work of other trades. Verify size and location of openings, recesses and chases with the trade requiring such items. Accurately place and securely support items to be built into forms.
- H. Cleaning and Tightening - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

3.03 FORMS COATINGS

Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

3.04 INSTALLATION OF EMBEDDED ITEMS

- A. General - Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be attached thereto.
- B. Edge Forms and Screens Strips for Slabs - Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screens required.

3.05 SHORES AND SUPPORTS

Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified. Submit a shore removal and reshoring schedule and drawings for the Engineer's review before proceeding with this work. Do not proceed until schedule and drawings have been reviewed.

3.06 REMOVAL OF FORMS

- A. Formwork not supporting concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 10⁰C (50⁰F) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operation, and provided that curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beams soffits, joists slabs and other structural elements should be removed according to the following table unless the concrete attains a minimum strength specified by the Engineer.

	Structural live load less than structural dead load	Structural live load more than structural dead load
Arch centers	14 days	7 days
Joist, beam, or girder soffits		
Under 10 ft. clear span between structural supports	7 days	4 days
10 to 20 ft. clear span between structural supports	14 days	7 days
Over 20 ft. clear span between structural supports	21 days	14 days
Slabs		
Under 10 ft. clear span between structural supports	4 days	3 days
10 to 20 ft. clear span between structural supports	7 days	4 days
Over 20 ft. clear span between structural supports	10 days	7 days

- C. Form Facing Material - may be removed four days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.07 RE-USE OF FORMS

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork. When forms are reused for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets.

END OF SECTION 03 10 00

SECTION 03 10 05
XYPEX ADMIXTURE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing of all labor, materials, services and equipment necessary for the supply and installation of crystalline waterproofing additive to concrete structures as indicated on the drawings and as specified herein. The admixture shall specifically be added to water-retaining concrete structures. The Xypex C-500 crystalline waterproofing material shall be added to concrete during the mixing cycle.
- B. Related Sections:
 - 1. Section 03 33 00 - Cast-In-Place Concrete

1.2 REFERENCES

- A. Applicable Standards: The following standards are referenced herein.
 - 1. American Society for Testing and Materials (ASTM)
 - 2. Army Corps of Engineers (CRD)
 - 3. American Concrete Institute (ACI)
 - 4. NSF International (NSF)

1.3 SYSTEM DESCRIPTION

- A. Crystalline Waterproofing Additive: Concrete waterproofing system shall be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. The system shall cause the concrete to become sealed against the penetration of liquids from any direction, and shall protect the concrete from deterioration due to harsh environmental conditions.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Testing Requirements: Crystalline waterproofing system shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein.
- B. Compressive Strength: Independent testing shall be performed according to ASTM C39 "Compressive Strength of Cylindrical Concrete Specimens". Concrete samples containing the crystalline waterproofing additive shall be tested against untreated control sample. At 28 days, the treated samples shall exhibit a minimum of 10% increase in compressive strength over the control sample.

1.5 SUBMITTALS

- A. Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for waterproofing applications. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents.
- B. Test Reports: Submit, for acceptance, complete test reports from approved independent testing laboratories certifying that waterproofing system conforms to performance characteristics and testing requirements specified herein.
- C. Manufacturer's Certification: Provide certificate signed by manufacturer or manufacturer's representative certifying that the materials to be installed comply in all respects with the requirements of this specification.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer to be ISO 9001 registered, and to have no less than 10 years experience in manufacturing the crystalline waterproofing additive for the required work. Manufacturer must be capable of providing field service representation during construction phase. Manufacturers that cannot provide the performance test data specified herein will not be considered for the project.
- B. Applicator: Installer of crystalline waterproofing additive shall be approved by the manufacturer or manufacturer's representative in writing.
- C. Pre-Installation Conference: Prior to installation of waterproofing, conduct meeting with ENGINEER, OWNER's representative, applicator (concrete supplier), concrete placer and waterproofing manufacturer's representative to verify and review the following:
 - 1. Project requirements for waterproofing as set out in Contract Document.
 - 2. Manufacturer's product data including application instructions.
- D. Technical Consultation: The waterproofing manufacturer's representative shall provide technical consultation on waterproofing application.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Delivery: Deliver packaged waterproofing materials to project site in original undamaged containers, with manufacturer's labels and seals intact.
- C. Storage: Store waterproofing materials in dry, enclosed location, at temperature and humidity conditions recommended by manufacturer.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer shall provide standard product warranty executed by authorized company official. Term of warranty shall be 15 years from Date of Substantial Completion.
- B. Labor warranty: If a factory authorized applicator is providing the material and admixing the material at the batch plant, then a labor warranty can be provided for the same period.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Acceptable Manufacturer: Xypex Chemical Corporation 13731 Mayfield Place, Richmond, B.C., Canada V6V 2G9 Tel: 800 961. 4477 or 604 273. 5265 Fax: 604.270.0451 E-mail: info@xypex.com Website: www.xypex.com
- B. Proprietary Products: Xypex crystalline waterproofing materials as follows:
 - 1. Xypex Admix C-500

Note: Supplemental specifications are available for Xypex Admix C-1000 NF (no fines grade) and Xypex Admix C-2000 NF (no fines grade).

- C. Substitutions: No substitutions permitted.
- D. Source Quality: Obtain proprietary crystalline waterproofing products from a single manufacturer.

2.2 DOSAGE

- A. General: Xypex Admix must be added to concrete mix at time of batching.
- B. Dosage Rate: Under normal conditions, the C-500 crystalline waterproofing powder shall be added to the concrete mix at a rate of 2% - 3% by weight of portland cement content.. For enhanced chemical protection or meeting specific project requirements, or where the concrete mix design contains higher than 20% fly ash content or includes a Portland cement/slag cement blend, consult with manufacturer or its authorized representative to determine appropriate dosage rates.

PART 3 EXECUTION

3.1 INSTALLATION

A. MANUFACTURER'S INSTRUCTIONS

1. Compliance: Comply with manufacturer's product data regarding installation, including technical bulletins, product catalogue, installation instructions and product packaging labels.

3.2 PROJECT CONDITIONS

- A. Reinforcement: All reinforcement shall be rib deformed bar in accordance with applicable standards. Exposed concrete decks (joint free) shall contain sufficient reinforcement to minimize thermal movement and control cracking.
- B. Setting Time and Strength: Some retardation of set may occur when using Xypex Admix. The amount of retardation will depend upon the concrete mix design, the dosage rate of the Admix, temperature of concrete and climatic conditions. Concrete containing Xypex Admix may develop higher ultimate strengths than plain concrete. Conduct trial mixes under project conditions to determine setting time and strength of the concrete. Consult with manufacturer or manufacturer's representative regarding concrete mix design, project conditions and proper dosage rate.
- C. Weather Conditions: For mixing, transporting and placing concrete under conditions of high temperature or low temperature, follow concrete practices as referred to in ACI 305R-77 (Hot Weather Concreting) and ACI 306R-78 (Cold Weather Concreting). For flatwork being placed in either hot, dry or windy conditions use of monomolecular film (evaporation retardant) is recommended to control loss of bleed water.

3.3 APPLICATION

- A. General: Xypex Admix shall be added to the concrete mix at time of batching. Thorough blending of the Xypex Admix throughout the concrete mix is essential for correct performance of the product and, therefore, care should be taken to ensure that a homogeneous mixture is obtained.
- B. Concrete Batching & Mixing: Procedures for mixing will vary according to type of batch plant operation and equipment.
- C. Ready Mix Plant - Dry Batching Operation: Add Xypex Admix powder to drum of ready-mix truck, then add 60% - 70% of required water along with 300 - 500 lb. (136 - 227 kg) of aggregate. Mix the materials for 2 - 3 minutes to ensure that the Admix is distributed evenly throughout the mix water. Add balance of materials to the ready-mix truck and mix in accordance with standard batch practices.
- D. Ready Mix Plant - Central Mix Operation: Mix Xypex Admix with water to form a very thin slurry (e.g. 15 - 20 lb. or 6.75 - 9 kg of powder mixed with 3 gal. or 13.6 l of water). Pour the required amount of material in drum of ready-mix truck. The aggregate, cement and water should be batched and mixed in the plant in accordance with standard practices

(taking into account the quantity of water that has already been placed in the ready-mix truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of the Xypex Admix throughout the concrete.

- E. Precast Batch Plant - Pan Type Mixer: Add Xypex Admix to the rock and sand, then mix thoroughly for 2 - 3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

3.4 CURING

- A. General: Concrete containing Xypex Admix shall be moist cured in accordance with ACI Reference 308, "Standard Practice for Curing Concrete".
- B. Curing Compounds: Curing compounds may be used in the event that project requirements or conditions prevent moist curing. Curing compounds shall comply with ASTM C-309.

3.5 PROTECTION

- A. Protection: Protect installed product and finished surfaces from damage during construction.

3.6 FIELD QUALITY CONTROL

- A. Examination for Defects: Do not conceal Xypex treated concrete before it has been observed by ENGINEER, waterproofing manufacturer's representative and other designated entities. Concrete shall be examined for structural defects such as faulty construction joints, cold joints and cracks. Such defects to be repaired in accordance with manufacturer's repair procedures.
- B. Flood Testing for Suspended Slabs:
 - 1. Perform flood test on completed waterproofing installation before placement of other construction.
 - 2. Plug or dam drains and fill area with water to a depth of two inches (50 mm) or to within 0.5 inch (12.5 mm) of top of waterproofing treatment.
 - 3. Let water stand for 24 hours.
 - 4. If leaks are discovered, make repairs and repeat test until no leaks are observed.

3.7 INTERACTION WITH OTHER MATERIALS

- A. Backfilling: Normal backfilling procedures may be used after concrete has been cured for at least seven days. If backfill takes place within seven days after concrete placement, then backfill material shall be moist so as not to draw moisture from the concrete. In no event shall backfilling take place before concrete has gained sufficient strength to withstand the applied load.
- B. Grout, Cement Parge Coat, Plaster or Stucco: Because concrete containing Xypex Admix

forms a relatively smooth surface and the resulting crystalline formation fills the concrete pores thereby reducing suction characteristics of the concrete, it may be necessary to use a suitable bonding agent for proper bonding of cementitious systems.

- C. Responsibility to Ensure Compatibility: Xypex Admix products are compatible with most admixtures used in the production of quality concrete. However, Xypex Chemical Corporation makes no representations or warranties regarding such compatibility of Xypex Admix products with other additives or admixtures, nor regarding compatibility of the Xypex treated concrete with coatings, plasters, stuccos, tiles or other surface-applied materials. It shall be the responsibility of the concrete contractor to take whatever measures are necessary, including testing, to ensure compatibility of the Xypex Admix with other additives or admixtures being used in the concrete mix, and it shall be the responsibility of the installer of the surface-applied material that is to be applied over the Xypex treated concrete to take whatever measures are necessary, including testing, to ensure acceptance by or adhesion to the Xypex treated concrete.

END OF SECTION 03 10 05

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SCOPE

This specification section covers the requirements for furnishing, detailing, fabricating, and placing reinforcing steel for cast-in-place concrete construction.

1.02 SUBMITTALS

- A. Fully detailed shop drawings, including bending schedules and bending diagrams, shall be submitted to the Engineer for review. Shop drawings shall show fabricating and placing details and size and location of all reinforcing steel. Shop drawings shall be prepared in accordance with the applicable requirements and guidelines of ACI 315.
- B. Shop drawings shall be of such detail and completeness that all fabrication and placement at the site can be accomplished. Shop drawings shall include number of pieces, sizes, and markings of reinforcing steel, laps and splices, supporting devices and accessories, and any other information required for fabrication and placement.
- C. Contract Drawings for anchor bolt schedules and locations, anchors, hangers, inserts, conduits, sleeves, and any other items to be cast in concrete shall be checked for possible interference with reinforcing steel. Required clearances shall be indicated on shop drawings.
- D. Refer to Section 01 33 00 for submittal requirements.

1.03 CERTIFICATION

Certified copies of mill tests on each heat or melt of steel stating the grade and physical and chemical properties of the reinforcing steel, and conformance with ASTM Specifications, shall be available to the Engineer at the time of inspection or sampling.

1.04 PRODUCT HANDLING

- A. Each bundle of steel reinforcement shall be tagged at the mill with a mill tag showing the name of the mill, melt or heat number, and type or grade of steel.
- B. Steel reinforcement shall be delivered to the jobsite, stored, and covered in a manner which will ensure that no damage shall occur to it from moisture, dirt, grease, or any other cause which might impair bond with concrete.

- C. Steel reinforcement shall be stored off the ground and shall be kept in a clean condition. Bars shall not be bent or straightened in a manner that will injure the material. Bars for the various contract items shall be stockpiled separately and shall not be used interchangeably.
- D. A sufficient supply of approved steel reinforcement shall be stored at the site at all times to ensure that there will be no delay of the work.
- E. Identification of steel reinforcement shall be maintained after bundles are broken.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing Bars: Reinforcing bars shall be new, deformed steel bars and shall conform to the requirements of ASTM A615, Grade 60. Only Grade 60 reinforcing bars will be permitted on the jobsite.
- B. Welded Wire Fabric: Welded wire fabric shall be new, rectangular mesh, welded, deformed steel wire fabric conforming to ASTM A185. Gauge or diameter of wire and center-to-center spacings of wire shall be as shown on the Drawings.
- C. Accessories: Reinforcement accessories, consisting of spacers, chairs, ties, and similar items required for spacing, assembling, and supporting reinforcement in place, shall conform with the applicable requirements of the reference standards hereinbefore specified.
 - 1. For footings or other concrete on grade, use supports with sand or precast concrete bases or plates or horizontal runners where wetted base materials will not support chair legs.
 - 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are hot-dip galvanized, plastic protected, or stainless steel protected.
- D. Tie Wire: Tie wire for reinforcement shall be No. 16 gauge or heavier, black, mild or commercial grade steel wire.

PART 3 - EXECUTION

3.01 CUTTING, BENDING AND SPLICING

- A. General: Fabrication of steel shall be in accordance with the Drawings and reviewed shop drawings. Where specific details are not indicated, comply with the applicable requirements of the reference standards hereinbefore specified.

- B. Cutting and Bending: Cutting and bending shall be performed at a central location, equipped and suitable for the purpose. Bars shall be accurately cut and bent as indicated on the Drawings. Bars shall be bent cold. Heating of bars for bending or straightening will not be permitted. Bars shall not be bent or straightened in any manner which will injure the material. All bars shall be labeled in accordance with bending diagrams and schedules, and like pieces secured in bundles if appropriate.
- C. Splicing: Splicing shall be lap splices conforming to ACI 318 unless otherwise shown on the Drawings. When splice information is missing, utilize Class "B" type per ACI 318-95. Reinforcing bars shall not be welded.
- D. Supplemental drawings will show locations of required splices and areas where splicing will not be permitted. The Contractor will be permitted to splice reinforcing steel at other locations for his convenience subject to the approval of the Engineer.

3.02 PLACING

- A. All reinforcing steel shall be placed accurately in the positions shown on the Drawings and held firmly during the placing and setting of concrete. When placed in the work, reinforcing shall be free from dirt, grease, paint or other foreign substances. The coating of epoxy-coated steel shall be unbroken with all damaged areas repaired as specified in ASTM D3963. Uncoated steel shall be free from loose mill scale, and heavy flaky rust that can be removed by firm rubbing with burlap or equivalent treatment. After being placed, the reinforcing shall be maintained clean until completely embedded in the concrete. Care shall be exercised to prevent any disturbance of the reinforcing in concrete that has already been placed.
- B. Welded wire fabric shipped in rolls shall be straightened into flat sheets before being placed.
- C. The CRSI-WCRSI "Recommended Practice for Placing Reinforcing Bars" shall be used as a guide for placing, supporting, and tying the reinforcing steel.
- D. Reinforcing shall be supported in position by means of concrete, metal or plastic chairs, metal hangers, metal spacers, or other satisfactory metal supports. Concrete blocks used for support purposes shall have a strength level and quality comparable to the concrete in which they are used. The use of broken stone, metal pipe, and wooden blocks will not be permitted. Concrete blocks shall be used for supporting reinforcing on subgrade. Stainless steel, concrete, plastic coated or plastic supports, as approved, shall be used for supporting reinforcing against surfaces which will be exposed to view in the finished structure. The use of nails driven into the forms to support the reinforcing steel will not be permitted. Reinforcing shall be placed so that there will be a clear distance of at least one inch between the reinforcing and any anchor bolts or other embedded metalwork.

- E. Unless otherwise specified, measurements made in placing reinforcing bars shall be to the centerline of the bars, except that cover shall be measured to the outside surface of the bar. No reinforcing steel shall be covered with concrete until it has been checked by the Engineer and his permission given to proceed with the concreting. The Engineer shall be given sufficient notice for inspection of the reinforcement.
- F. All laps, hooks, and bends in reinforcing bars shall conform to the requirements of ACI 315 and ACI 318 unless otherwise shown on the Drawings. Bars in lapped splices shall be in contact and tied in such manner as to maintain at least the specified minimum clearances to adjacent bars and the specified minimum covers. Lap splices of closely spaced bars shall be staggered when possible and where required by or permitted by the Engineer.
- G. Welded wire fabric shall be lapped sufficiently to maintain uniform strength and shall be securely fastened at the ends and edges. The laps shall conform to the requirements of CRSI Publication, "Placing Reinforcing Bars."
- H. The minimum concrete clear cover over reinforcing steel shall be 3 inches where the concrete is against soil. In all other cases, the minimum concrete coverage for steel reinforcement shall be as specified in ACI 318, Section 7.7, unless otherwise shown on the Drawings.
- I. Tolerances for Placing Reinforcing Steel:

- 1. Variation of protective covering:

<u>Clear Cover</u>	<u>Maximum Variation</u>
6 inch	2 inch
4 inch	3/8 inch
3 inch	3/8 inch
2 inch	1/4 inch
1-1/2 inch	1/4 inch
1 inch	1/8 inch
3/4 inch	1/8 inch

- 2. Variation from indicated spacing: One bar diameter or 1-inch maximum.

3.03 CLEANING

Reinforcement at time of depositing concrete shall be free of all coatings which might impair bond with concrete, such as form oil, curing compound, mud or heavy deposits of rust.

3.04 NOTIFICATION AND INSPECTION

Contractor shall notify the Engineer at least 24 hours ahead of each concrete placement, and no concrete shall be placed until all reinforcing steel has been inspected by the Engineer after installation by the Contractor.

3.05 CORRECTION DURING CONCRETE PLACEMENT

Capable steel workers shall be kept on the work at all times during the placing of concrete, and they shall properly reset any reinforcement displaced by runways, workers, or other causes. Reinforcement shall not be bent after being partially embedded in hardened concrete.

3.06 DEFECTIVE WORK

- A. The following reinforcing steel work will be considered defective and may be ordered by the Engineer to be removed and replaced by the Contractor at no additional cost to the Owner:
1. Bars with kinks or bends not indicated on Drawings;
 2. Bars injured due to bending or straightening;
 3. Bars heated for bending or straightening;
 4. Bars with broken epoxy coating;
 5. Reinforcement not placed in accordance with the Drawings or Specifications;
 6. Bars that have been welded.

END OF SECTION 03 20 00

SECTION 03 25 30
CONCRETE JOINTS AND WATERSTOPS

PART 1 - GENERAL

1.01 SCOPE

- A. This Specification Section covers the furnishing and installing of concrete waterstops, and other concrete jointing material.
- B. The Contractor shall construct expansion, contraction and construction joints in the concrete work as shown on the Drawings or as directed by the Engineer. The Engineer may require that a waterstop be placed in any or all types of joints.

1.02 DEFINITIONS

- A. Expansion joint is defined as a joint filled with resilient material to permit concrete dimensional change without damage to the concrete.
- B. Contraction joint is defined as a concrete surface on or against which new concrete is to be placed to provide for volumetric shrinkage of monolithic units or movement between monolithic units but not bonded. The surface of the concrete first placed at a contraction joint shall be coated with sealing compound before the concrete on the other side of the joint is placed.
- C. Construction joint is defined as a concrete surface that has reached its final setting and on or against which new concrete is placed. Construction joints not indicated on the Drawings shall be so made and located as to least impair the strength of the structure. The Contractor shall show on his submittal drawings the proposed locations of all construction joints for the Engineer's review.

1.03 SUBMITTALS

- A. The Contractor shall provide a manufacturer's certificate warranting compliance of each material with this specification. The certificate shall identify the material, quantity, batch number, and date of manufacture.
- B. Unless otherwise directed, the Contractor shall submit to the Engineer samples of materials to be used.

1.04 QUALITY ASSURANCE

- A. It is required that all waterstop field joints and mastic installation shall be subject to continuous, rigid observation and no such work shall be scheduled or started without prior arrangements with the Engineer for observation.

- B. All field joints in PVC waterstop shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be removed from the site and disposed of by the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL

All materials placed in contact with each other shall be checked for mutual compatibility.

2.02 WATERSTOPS

- A. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinylchloride (PVC) compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Drawings. No reclaimed PVC shall be used in the compound. Manufacturer shall be Greenstreak, Durajoint or approved equal.

- B. The finished waterstop material shall meet the following minimum requirements:

Tensile strength	2,000 psi min.	(ASTM D-638)
Ultimate elongation	350% min.	(ASTM D-638)
Shore hardness	75 ± 5	(ASTM D-2240)
Specific gravity	1.38 max	(ASTM D-792)
Stiffness in flexure	700 psi min.	(ASTM D-747)
Cold brittleness	No Failure at -35°F	(ASTM D-746)
Water absorption: 48 hours	0.15% max	(ASTM D-570)
Tear Resistance	290 lb./in. min.	(ASTM D-624)

- C. Factory made waterstop joints shall have a tensile strength across the joint equal to at least 600 psi. Field splices and joints shall be made in accordance with the waterstop manufacturer's instructions using a thermostatically-controlled heating iron.

2.03 JOINT SEALANT

- A. Joints shall be sealed using Sikaflex-2c NS EZ, or approved equal, and shall meet the requirements of ASTM C-920, Type M, Grade NS, Class 25 and FS-TT-S-00227E, Type II, Class A, and shall be NSF 61 certified. Color shall match color of concrete reservoir.
- B. All joints receiving a joint sealant shall be primed using Sikaflex Primers 429/202, or approved equal.

PART 3 - EXECUTION

3.01 EXPANSION, CONTRACTION, AND CONSTRUCTION JOINTS

- A. General: Joint locations and details not shown on the Drawings shall be in accordance with a plan or schedule submitted to and accepted by the Engineer. In no case shall any fixed metal, embedded in concrete, be continuous through an expansion or contraction joint.
- B. Construction Joint Treatment: As a lift is completed, the surface shall be protected immediately from any condition that will damage the concrete.
- C. Cleaning: Horizontal and vertical construction joints and other construction joints indicated to be bonded shall be prepared for receiving the next lift by cleaning with either wet sandblasting or high-pressure water jet shall be equal to that obtained with wet sandblasting.
- D. Vertical Construction and Contraction Joints: Bond is expected in vertical construction joints, and they shall be cleaned. Bond is not expected in vertical contraction joints, and they shall be coated with a bond breaker compound. Curing compound on the joint may serve this purpose. The entire substructure of the pumping plant shall be a monolith with no contraction joints permitted.

3.02 INSTALLING WATERSTOP

- A. Waterstop shall be embedded in the concrete with equal portions on both sides of the joint unless shown otherwise on the Drawings, and the concrete carefully placed and vibrated to ensure a complete filling and bond between the concrete and waterstop.
- B. Waterstop material shall be laid in the longest practicable length, with joints spliced to form a continuous watertight seal, and shall be supported and protected from becoming damaged. Damaged waterstop shall be replaced at the Contractor's own expense.
- C. PVC waterstop shall be stored so as to permit free circulation of air around the material and to protect it from direct rays of the sun.
- D. In the event any PVC waterstop is installed in the concrete on one side of a joint and will remain unembedded for more than 2 days, suitable precautions shall be taken to shade and protect the exposed material from the direct rays of the sun until the entire waterstop is embedded in concrete.

END OF SECTION 03 25 30

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work included - Provide all cast-in-place concrete, in place, as indicated on the Drawings, specified herein, and needed for a complete and proper installation.

1.02 QUALITY ASSURANCE

A. Standards

1. Perform cast-in-place concrete work in accordance with ACI 318, latest edition.
2. Comply with other standards specified in this Section.
3. In case of conflict between the referenced standards, the more stringent requirements shall govern.

B. Qualifications of Installers

1. Throughout the progress of installation of the work of this Section, provided at least one person who shall be thoroughly familiar with the specified requirements, completely trained and experienced in the necessary skills, and who shall be present at the site and shall direct all work performed under this Section.
2. In actual installation of the work of this Section, use adequate numbers of skilled workmen to ensure installation in strict accordance with the approved design.
3. In acceptance or rejection of work performed under this Section, the Engineer will make no allowance for lack of skill on the part of workmen.

C. Quality Control

1. Inspection and testing of concrete shall be performed by a testing firm selected by the Owner. All testing shall be paid for by the Owner.
2. Contractor shall coordinate with Owner's testing firm and shall provide minimum notice of 48 hours prior to concrete pours.

3. Do not begin concrete production until all mixes have been reviewed by the Engineer.
4. Testing. The determination of compressive strength in psi will be made by testing 6-inch diameter by 12-inch cylinders, made and cured in accordance with specifications for "Making and Curing Concrete Compression and Flexural Strength Test Specimens in the Field (ASTM C31) and the "Test for Compressive Strength of Cylindrical Concrete Specimens" (ASTM C39). Tests and analyses of the aggregates and of the resulting concrete will be made by the Engineer at frequent intervals from the Trial Batch specified in Section 1.02 C 4a. The mixes used shall be changed whenever, in the opinion of the Engineer, such change is necessary or desirable to secure the required workability, density, impermeability, surface finish and strength, and the Contractor shall be entitled to no additional compensation because of such changes. The cost of all laboratory tests on cement, aggregates, and concrete will be borne by the Contractor, and the Contractor shall provide test cylinders and assist the Engineer in obtaining specimens for testing.

Determine strength per ASTM C 39. Test 1 cylinder at 7 days, 2 cylinders at 28 days and 1 cylinder at 56 days if the average of the 28 day cylinders is not at the specified strength.

1.03 SUBMITTALS

- A. General - Comply with provisions of Part 2.
- B. Product data - within 30 calendar days after award of Contract submit:
 - (1) Complete materials list of items proposed to be furnished and installed under this Section;
 - (2) Sufficient data to demonstrate compliance with the specified requirements;
 - (3) Complete description of proposed curing methods;
 - (4) Complete mix designs, prepared in accordance with the provisions of subparagraph 1.02 C1 above.
- C. Shop Drawings - Accompanying the above submittal, submit complete Shop Drawings including, but not necessarily limited to:
 - (1) Location of all proposed construction joints, keying, and water stops;
 - (2) Location of all openings, depressions, construction and control joints, trenches, sleeves, inserts, and other items affecting reinforcement and placing of concrete.

1.04 PRODUCT HANDLING

- A. Protection - Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the work and materials of all other trades.
- B. Replacement - In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 CONCRETE

- A. Concrete shall be designed in accordance with ACI Standard Recommended Practice for Design of Concrete mixes latest edition to produce the strength for each type of concrete with the slumps and maximum sizes of coarse aggregates specified. Compressive strength, maximum water content, and maximum slump shall conform to the following:

Concrete unless otherwise specified:

- 1. Compressive Strength at 28 days = 4,000 psi for slabs, 3500 psi for footings and foundations.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
 - 4. Cement Content: Minimum 611 pound per cubic yard; 6.5 bag mix.
 - 5. Water-Cement Ratio: Maximum 45 percent by weight.
 - 6. Total Air Content: 5 to 7 percent for concrete exposed to freezing and thawing; and 2 to 4 percent for other concrete; per ASTM C 173.
 - 7. Maximum Slump: 4 to 2 inches for structures; 3 to 1 1/2 inches for blocks and pavement.
 - 8. Maximum Aggregate Size: one inch.
- B. Concrete designated as "lean concrete":
 - 1. Compressive strength at 28 days = 2,000 lbs/sq inch.
 - 2. Minimum Cement Content = 4 sacks/cu yd.
- C. Thrust Block Concrete: Thrust and anchor block concrete shall conform with this specification with the exception of the following items:
 - 1. Type I or II Portland Cement may be used.

2. The maximum water cement (W/C) ratio shall be .50.
3. The average 28-day strength of three consecutive tests shall not fall below 3000 psi.
4. A water-reducing admixture will not be required.

2.02 CEMENT

A. General

1. All Portland Cement shall conform to the requirements of ASTM C150.
2. Cement to be used in construction at or below grade shall comply with the requirements of Type II.
3. Cement for above grade construction shall be Type II or Type V.
4. Do not use cement having a temperature greater than 60 degrees C (140 degrees F).

B. Sequence of Use - Use only one brand of cement for the entire work and use in the same sequence as received at the site.

C. Mill Tests - Furnish mill tests for all cement. The 28 day cube strength results may be submitted in a separate report but shall be related to the specific batch tested.

2.03 AGGREGATE

A. General - All aggregates shall conform to requirements of ASTM C 33, except as modified below:

<u>U.S. Size</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>
3/8 inch	100	100	100
No. 4	100	100	100
No. 8	98-100	90-100	98-100
No. 16	55-90	75-100	90-100
No. 30	35-59	69-79	80-100
No. 50	8-30	12-40	15-50
No. 100	0-10	0-10	0-15

B. Coarse Aggregates

1. Coarse aggregate shall be crushed stone complying with ASTM C33.
2. If the Contractor demonstrates to the Engineer by tests that a finer gradation can be used with the proposed fine aggregate to produce an equal or better quality concrete, the use of the finer gradation will be

approved by the Engineer when complete substantiating data is submitted and approved.

3. Quality Comparisons will be made on compressive strength, flexural strengths, workability, and drying shrinkage.
- C. Aggregate Sources - Provide aggregates from one source of supply only.
- D. Aggregate sizes
1. Maximum aggregate size shall be not larger than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars or bundles of bars.
 2. Stockpile the aggregate in a manner to protect from contamination.

2.04 WATER

Water used as an ingredient in concrete shall be clean, potable, and free from injurious amounts of foreign matter.

2.05 CONCRETE ADMIXTURES

- A. Air Entraining Agent. An air-entraining agent meeting the requirements of "Specifications for Air Entraining Admixtures for Concrete" (ASTM C260) shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 2 to 4 percent; provided that, when the mean daily temperature in the vicinity of the worksite falls below 40°F for more than one day, the total air content provided shall be 4 to 8 percent. The Owner reserves the right, at any time, to sample and test the air-entraining agent received on the job by the Contractor. In no event shall any of said agent be used for work under the contract without approval by the Engineer. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.
- B. Water-Reducing Agent. At the Contractor's option, or at the request of the Engineer, but in either case at the expense of the Contractor, an admixture may be added to the concrete to control the set, effect water reduction and increase workability. Such admixtures may be either a hydroxylated carboxylic acid type or a hydroxylated polymer type, but shall contain no calcium chloride. The required quantities of cement shall be used in the mix regardless of whether or not any admixture is used.

The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions. Where the air temperature at the time of

placement is expected to be consistently over 80°F, such admixture shall be Super Concrete Emulsion's "Plastiment," Master Builder's "Pozzolith 300R," or equal. Where the air temperature at the time of placement is expected to be consistently under 40°F, such admixture shall be Super Concrete Emulsion's "Plastocrete A," or equal.

- C. Calcium Chloride. The use of calcium chloride in concrete will not be permitted.

2.06 CURING MATERIALS

- A. Burlap mats weighing approximately 305 grams per square feet (9 oz. per square yard) for moist curing shall conform to AASHTO M182.
- B. Liquid curing compound shall be Hunt Process 225-TU as manufactured by Hunt Process Company, Santa Fe Springs, California or equal. It shall contain a fugitive dye so that areas of application will be readily distinguishable for a 30-day period in the sunlight.
- C. Asphalt emulsion damp-proofing agent shall be Laykold Waterproofing as manufactured by Chevron Asphalt Company, Oakland, California or equal.

2.07 OTHER MATERIALS

- A. Waterstops shall be extruded from an elastomeric polyvinylchloride compound and shall be as manufactured by Water Seals, Inc., Chicago, Illinois or equal. No reclaimed or scrap material shall be used.
 - (1) Flat-strip waterstops shall have a minimum thickness of 3/16 of an inch and shall be as shown in the drawings.
 - (2) Center-bulb waterstops shall be as shown on the drawings.
 - (3) Fittings shall be used at intersections of all ribbed waterstops.
- B. Vapor barriers shall be polyethylene sheets having a minimum thickness of 0.2 mm.
- C. Construction joint sealant shall be polyurethane polymer designed for bonding to concrete which is continuously submerged in water. No material will be acceptable which has an unsatisfactory history as to bond or durability when used in the joints of hydraulic structures. Surface to be sealed shall be primed with primer supplied by the same manufacturers supplying the sealant. No sealant will be permitted to be used without a primer.
- D. Concrete floor hardener shall be Conrad Sovig Company, "K-Natural," or equal.

- E. Metallic aggregate, heavy-duty finish, shall be packaged ground and graded cubicle-iron particles with dispersing agents formulated to blend with portland cement for monolithic surface treatment. Use iron aggregate free from nonferrous metals, oil, grease, rust, and other impurities.
- F. Nonshrink grout shall be a ready-to-use metallic aggregate product requiring only the addition of water at the job site, and shall have the following attributes:
 - (1) Be capable of producing a flowable grouting material having no drying shrinkage or settlement at any age;
 - (2) The compressive strength of grout (50 mm or 2" cubes) shall be not less than 350 kg per sq. cm (5,000 psi) at age seven days, and 527 kg per sq. cm (7,500 psi) at age 28 days.
 - (3) Store, mix, and place the nonshrink grout in strict accordance with manufacturer's recommendations as approved by the Engineer.

2.08 BATCHING, MIXING, AND DELIVERY EQUIPMENT

- A. Use transit-mixed concrete from approved batching and mixing plant. Batch, mix, and transport concrete to site in accordance with provisions of ASTM C 94.

2.09 PUMPING OF CONCRETE

- A. General. Pumping of concrete will be permitted only with the Engineer's approval. If in the Engineer's opinion, the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. Pumping Equipment.
 - (1) The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
 - (2) The minimum diameter of the hose (conduit) shall be 4 inches.
 - (3) Pumping equipment and hoses (conduits) that, in the opinion of the Engineer, are not functioning properly, shall be replaced.
 - (4) Aluminum conduits for conveying the concrete will not be permitted.
- C. Proportioning. Concrete shall conform to specifications subsections 2.01 through 2.05.

- D. Field Control. Concrete samples for slump (ASTM C143) and test cylinders (ASTM C31 and C39) will be taken at the placement (discharge) end of the line.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 CONCRETE PLACEMENT

- A. General - Place concrete in compliance with practices and recommendations of ACI 304, and as herein specified. Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these specifications, or which is of inferior quality, as determined by the Engineer, shall be removed and replaced by and at the expense of the Contractor. No concrete shall be placed except in the presence of duly authorized representative of the Engineer.

B. Procedures

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
2. If a section cannot be placed continuously, provide construction joints as herein specified.
3. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic.
4. Deposit concrete as nearly as practicable in its final location to avoid segregation due to rehandling and flowing.
5. Do not subject concrete to any procedure which will cause segregation.
6. Screen concrete which is to receive other construction to the proper level to avoid excessive skimming and grouting.
7. Do not use concrete which becomes nonplastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials.

8. Remove rejected concrete from the site and dispose of it in a location approved by the Engineer for that purpose.

C. Order of Placing Concrete.

- (a) The order of placing concrete in all parts of the work shall be subject to the approval of the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the drawings. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 7 days before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until all the adjacent wall panels have cured at least 14 days.

D. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment, and to the locations of final deposit, as rapidly as practicable and by methods which will prevent segregation and loss of concrete mix materials.
2. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit.
3. Keep interior surfaces of conveying equipment. Free from hardened concrete, debris, water, and other deleterious materials.
4. Pumps may be used only if they can pump the mix designed. Do not add fine aggregate or water to the mix to satisfy needs of a pumping device.
5. Use chutes or tremies for placing concrete where a drop of more than 2 m (72") is required.
6. Where free drop through tremies exceeds 6 m (18'-0"), use flow checking devices.

E. Placing Concrete in Forms

1. Deposit concrete in forms in horizontal layers not deeper than 60 cm (24"), and avoid inclined construction joints.
2. Where placement consists of several layers, place each layer while preceding layer is still plastic and to avoid cold joints.
3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Do not place concrete in supporting elements until the concrete previously placed in columns and walls is no longer plastic.

F. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placement by use of the specified equipment, thoroughly working concrete around the reinforcement and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on grade, as specified for formed concrete structures.
4. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other methods acceptable to the Engineer.
5. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.
6. Bring slab surfaces to the correct level with a straightedge, and then strike off.
7. Use bullfloats or darbies to smooth the surface, leaving it free from bumps and hollows.
8. Do not sprinkle water on the plastic surface; do not disturb the slab surfaces prior to start of finishing operations.
9. Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the pour. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the pour screeded in an up-slope direction.

G. Hot Weather Placing - Comply with ACI 305.

1. When hot weather conditions exist which would seriously impair the quality and strength of concrete, place the concrete as follows:
 - (1) Maintain concrete temperature at time of placement below 32 degrees C (90-deg F). Use chilled mixing water or chopped ice to control concrete temperature, provided the water equivalent of the ice is calculated to the total amount of water.

- (2) Cover reinforcing steel with water-soaked burlap if the steel becomes too hot. Steel temperature shall not exceed the ambient air temperature immediately prior to placement of concrete.
- (3) Wet forms thoroughly prior to placement of concrete.
- (4) Use set-control admixtures in the mix.

H. Cold Weather Placing. Comply with ACI 306.

1. Earth foundations shall be free from frost or ice when concrete is placed upon or against them.
2. Design mix, mixing procedures, placing, finishing and curing of concrete when the concrete temperature is lower than 55 degrees F or when the temperature of the air is lower than 40 degrees F shall be deemed "cold weather" concrete work and shall require additional and special procedures for such work.
3. Concrete aggregates shall be warmed, water shall be warmed, and all equipment shall be kept as near concrete temperature as possible. Water-cement ratio shall be carefully adjusted to prevent excessive cooling or possible freezing. An excessively low temperature conditions, all areas to receive concrete shall be protected with enclosures and the temperature maintained above the allowed minimum with space heaters or similar equipment.
4. After concrete is placed and compacted the finishing shall be done as quickly as possible and the concrete retained at a temperature of not less than 50 degrees F for at least 72 hours, after which time the temperature may be reduced at the rate of not more than one degree F per hour for the first 24 hours. Calcium chloride, other salts, or foreign materials shall not be used in concrete to prevent freezing.
5. During curing, freezing of concrete shall be prevented. Any concrete frozen before completely cured shall be removed and replaced by the Contractor at no additional cost to the Owner.
6. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying.

3.03 CONSOLIDATION

A. General

1. Consolidate all concrete in accordance with provisions of ACI 309.

2. Consolidate each layer of concrete immediately after placing, by use of internal concrete vibrators supplemented by hand-spading, rodding, or tamping.
3. Do not use vibrators to transport concrete inside the forms.
4. During all phases of operation, maintain a frequency of not less than 10,000 vibrations per minute per internal vibrator.
5. Do not vibrate forms or reinforcement.

B. Equipment

1. Provide adequate number of units and power source at all times. Maintain spare units on hand to ensure adequacy.
2. If, in the opinion of the Engineer, the equipment being used is not adequate to accomplish proper consolidation, the Engineer may order delay in further placement of concrete until such equipment is available for use at the location of placement of concrete.

C. Procedures

1. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation of aggregates.
2. Insert the vibrator so as to penetrate the lift immediately below the one being placed, and manipulate to blend the two lifts.
3. Do not insert the vibrator into lower courses which have begun to set.
4. Use the vibrator to melt down the concrete as it is being placed, and use the vibrator to consolidate the mass of concrete.
5. In the case of wall construction, assign at least one vibrator and vibrator-operator to melting down the mix; and assign at least one other vibrator and vibrator-operator to consolidating the mass of concrete.
6. Spacing between insertions of the vibrator which is used to consolidate shall not exceed twice the radius of action as shown in table 5.1.4 of ACI 309.
7. Under no circumstances shall the points of insertion during the consolidation phase be more than 45 cm (18") apart.

D. Maintenance of Vibrators - Initiate a maintenance program for the vibrators to assure that they are operating at peak efficiency at all times, and to facilitate effective consolidation of the concrete.

3.04 JOINTS

A. Construction Joints.

1. General.

- (a) Construction joints shall be provided where shown on the drawings. If construction joints necessary for the progress of the work are not shown on the drawings, show them in complete detail on the Shop Drawings required under paragraph 1.03 C.
- (b) Provide keyways 1 1/2 inch deep in all construction joints in walls, slabs, and between footings and walls.
- (c) Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints.
- (d) Except where otherwise shown or specified, at all joints where waterstops are required, the joint face of the first pour shall be coated with liquid curing compound (paragraph 2.06 B). The surfaces of the groove for the sealant shall not be coated.

2. Construction Joint Sealant.

- (a) Where shown, construction joints in floor slabs shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used for forming the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sandblasted. The grooves shall be allowed to become thoroughly dry, after which they shall be blown out; immediately thereafter, they shall be primed and filled with the construction joint sealant. The primer and sealant shall be placed strictly in accordance with the recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. All sealant shall cure at least 7 days before the structure is filled with water.
- (b) All sealant shall be installed by a competent waterproofing subcontractor who has a successful record of performance in similar installations. Before work is commenced, the crew doing the work shall be instructed as to the proper method of application by a representative of the sealant manufacturer. The Contractor shall provide a 5-year written guarantee of the entire sealant installation against defects in materials and workmanship, together with a statement that he agrees to repair or replace, to the

satisfaction of the Owner, at not cost to the Owner, any such defective areas which become evident within said 5-year guarantee period.

3. Waterstops. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are used, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated.
- B. Isolation Joints in Slabs on Grade. Provide isolation joints in slabs on grade at point of contact between slabs on grade and vertical surfaces where indicated. Caulk in accordance with the provisions of Section 07900.
- C. Control Joints in Slabs on Grade. Provide control joints in slabs on grade to form panels or patterns as shown. Use one of the following alternates:
 - (1) Cast a formed sheet metal key in the slab.
 - (2) Insert a pre-molded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured for at least seven days, remove inserts and clean loose debris from the joint. Caulk all joints.

3.05 CONCRETE FINISHING

- A. Finish of Formed Surfaces
 1. Rough Form Finish
 - (1) Provide as-cast rough form finish to formed concrete surfaces that are to be concealed in the finish work or by any other construction.
 - (2) Standard rough form finish shall be the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched, and all fins and other projections exceeding 6 mm (1/4") in height rubbed down or chipped off.
 2. Smooth Form Finish
 - (1) Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view, or that are to be covered with a coating material other than cement plaster applied directly to the concrete.

- (2) Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams.
 - (3) Repair and patch defective areas with all fins and other projections completely removed and smoothed.
3. Related Unformed Surfaces - At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a smooth troweled finish.

B. Monolithic Slab Finishes

1. Scratch Finish

- (1) Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for terrazzo tile and other bonded applied cementitious-finish flooring material.
- (2) After placing slabs, plane the surface to a tolerance not exceeding 6 mm (1/4") in 60 cm (24") when tested with a straightedge.
- (3) Slope uniformly to drains where required.
- (4) After leveling, roughen the surface before its final set by using a stiff broom, a brush, or a rake.

2. Float Finish

- (1) Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as specified, and to slab surfaces which are to be covered with insulation, and as otherwise shown on the Drawings or in the schedules.
- (2) After placing concrete slabs, do not work the surface further until ready for floating.
- (3) Begin floating when the surface water has disappeared and when the concrete has stiffened sufficiently to permit operation of a power driven float, or both.
- (4) Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units.
- (5) Check and level the surface plane to a tolerance not exceeding 6 mm (1/4") in 3 m (10'-0") when tested with a 3 m (10'-0") straightedge placed on the surface at not less than two different angles.

- (6) Cut down high spots and fill low spots.
- (7) Uniformly slope to drains where required.
- (8) Immediately after leveling, refloat the surfaces to a smooth, uniform, granular texture.

3. Trowel Finish

- (1) Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and to slab surfaces that are to be covered with resilient flooring, carpeting, paint, or other thin-film finish coating system.
- (2) After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
- (3) Consolidate the concrete surface by the final hand troweling operation, free from trowel marks, uniform in texture and appearance, and with a surface plane to tolerance not exceeding 3 mm (1/8") in 3 m (10'-0") when tested with a 3 m (10'-0") straightedge.
- (4) Grind smooth those surface defects which would telegraph through applied floor covering system.

4. Nonslip Broom Finish

- (1) Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as shown on the Drawings or in the schedules.
- (2) Immediately after trowel finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use a fiber bristle broom.
- (3) Coordinate the required finish with the Engineer prior to application.

5. Chemical Hardener Finish

- (1) Apply chemical hardener finish to all exposed dry interior concrete floors.

- (2) Apply liquid chemical hardener after complete curing and drying of the concrete surface.
 - (3) Dilute the liquid hardener with water and apply three coats:
 - a. First Coat: 1/3 strength
 - b. Second Coat: 1/2 strength
 - c. Third Coat: 2/3 strength
 - (4) Evenly apply all coats allow 24 hours drying time between coats.
6. Heavy-Duty Wear-Resistant Finish.
- (1) Provide heavy-duty wear-resistant finish to slab surfaces maintenance area of the Control Building.
 - (2) Premix Portland Cement and required dispersing agents, and deliver to the site in moisture-resistant sealed bags.
 - (3) Apply the premixed material at the manufacturer's recommended rate, providing not less than 7.35 kg of material per sq. m (1.4 lbs. per sq. ft.).
 - (4) Immediately following the first floating operation, uniformly distribute over the concrete surface approximately 1/2 of the specified weight of the blended dry shake materials, and embed with power floating.
 - (5) After the first dry shake application has been embedded, uniformly distribute the remaining portion of blended dry shake material at right angles to the first application, and embed by power floating.
 - (6) Comply with manufacturer's application instructions.
 - (7) After completion of broadcasting and floating, apply a trowel finish as specified herein.

3.06 CURING AND DAMPPROOFING

- A. General. All concrete shall be cured for not less than 14 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following subsections.

<u>Surface to be Cured or Dampproofed</u>	<u>Method</u>
Unstripped wooden forms	1

Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this subsection	4
Floor slabs in hydraulic structures and exterior surfaces of exposed roof slabs	5
Exterior buried surfaces of walls	6
- (1) Method 1. Wooden forms shall be wetted immediately after concrete has been poured and shall be kept wet with water until removed. If forms are removed with 14 days of placing the concrete, curing shall be continued in accordance with the applicable method.
 - (2) Method 2. The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
 - (3) Method 3. The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed.
 - (4) Method 4.
 - (a) The surface shall be sprayed with a liquid curing compound which will not affect the bond of paint to the concrete surface. It shall be applied in accordance with the manufacturer's instructions at a maximum coverage rate of 200 square feet per gallon in such a manner as to cover the surface with a uniform film which will seal thoroughly.
 - (b) Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.
 - (c) Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

- (d) Where curing compound is specified, it shall be applied within 2 hours after completion of the finish on unformed surfaces, and within 2 hours after removal of forms on formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as provided under subsection 3.08.
5. Method 5. Immediately after the concrete has been troweled, it shall be given a coat of curing compound in accordance with subsection (e), herein. Not less than 1 hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall consist of one of the following two types:
- (a) Sheets of heavy, waterproof sisalkraft paper laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with the edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.
 - (b) Sheets of clear polyethylene having a thickness of not less than 6 mils laid with edges butted together and with the joints between sheets sealed with 1-inch wide strips of acetate tape.

The curing blankets shall be left in place during the 14-day curing period and shall not be removed until after concrete for adjacent work has been placed. Should the curing blankets become torn or otherwise ineffective, the Contractor shall replace damaged sections. During the first 7 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket.

6. Method 6.

- (a) The surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion immediately after the wall forms have been removed. The asphalt emulsion shall be approved by the Engineer. Application shall be in two coats. The first coat shall be diluted to

2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the specified material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon.

3.08 REMEDIAL WORK

- A. General. Reinforce or replace deficient work as directed by the Engineer and at no additional cost to the Owner.
- B. Care and Repair of Concrete. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the specifications, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.
- C. Treatment of Surface Defects.
 - 1. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer, and then only in strict accordance with his directions. Concrete containing voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced; provided that where required or approved by the Engineer, defects shall be repaired with gunite or with cement mortar placed by an approved compressed air mortar gun. In no case will extensive patching of honeycombed concrete be permitted. All repairs and replacements herein specified shall be promptly executed by the Contractor at his own expense.
 - 2. Defective surfaces to be repaired as specified in subsection (a) hereof shall be cut back from trueline a minimum depth of 2-inch over the entire area. Feathered edges shall be avoided. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast.

After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with gunite or with cement mortar so that while the

repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair purposes shall consist of a mixture of 1 sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

3. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed mortar. Holes left by form tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed mortar.
4. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of Section 03300, subsection 3.05, using approved methods which will not disturb the bond, cause sagging, or horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.
5. Prior to filling any structure with water, any cracks that may have developed shall be "vee'd" as shown on the drawings and filled with sealant conforming to the requirements of subsections 2.07 C and 3.04 A of this section.

3.09 TOLERANCES

- A. General. The Contractor shall set and maintain concrete forms so as to ensure that the completed work is within the tolerances specified herein. "Tolerance" is defined as the permissible variation from lines, grades, or dimensions shown on the drawings. Where tolerances are not stated in the specifications, permissible deviations will be according to ACI 347.
- B. Special Tolerances.

	<u>Item</u>	<u>Tolerance</u>
1.	Variation of the constructed linear outline from the established position in plan	In 10 feet: 1/4 inch In 20 feet or more: 2 inch
2.	Variation from the level or from the grades shown on the drawings	In 10 feet: 1/4 inch In 20 feet or more: 2 inch
3.	Variation from the plumb	In 10 feet: 1/4 inch

In 20 feet or more: 2 inch

4.	Variation in the thickness of slabs and walls	Minus 1/4 inch Plus 2 inch
5.	Variation in the locations and sizes of slab and wall openings	+ 1/4 inch

END OF SECTION 03 30 00

SECTION 05 50 00
MISCELLANEOUS METALWORK

PART 1 GENERAL

1.01 DESCRIPTION

This section provides specifications for steel accessories, including seat angles, supports and brackets, and other miscellaneous metalwork.

1.02 QUALITY ASSURANCE

Shop and field welding shall conform to the requirements of the AISC specifications.

The use of salvaged, reprocessed or scrap materials will not be permitted.

PART 2 - PRODUCTS

2.01 GRATING

- A. Grating shall be supported around all sides of an opening with support members. Unless otherwise indicated, grating supported on concrete shall have embedded angles that match the grating material. Grating shall be serrated bar grating, unless noted otherwise on the Drawings.
- B. The grating shall be completely banded at edges and cutouts and the banding shall be welded to each cut bearing bar. The banding material and cross-section shall be the same as the bearing bars.
- C. Grating pieces shall be fastened to each support at a minimum of 2 locations.
- D. Grating deflection shall not exceed 1/4 inch or the span divided by 180, whichever is less.
- E. For standard duty grating, the loading to be used for determining stresses and deflections shall be the uniform load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds. For heavy duty grating the loading used shall be in accordance with AASHTO HS-20.
- F. Standard duty grating shall be fabricated from steel and hot-dip galvanized, unless noted otherwise. Standard duty grating that will be submerged, partially submerged, or in a corrosive environment shall be fabricated entirely of Type 316 stainless steel.
- G. No single piece of standard duty grating shall weigh more than 80 pounds, unless noted otherwise on the Drawings. All crossbars shall be welded into position.
- H. Heavy duty grating shall be fabricated from welded steel and hot-dip galvanized after fabrication. All crossbars shall be welded into position.

- I. Bar dimensions shall be 1-1/4 inch by 3/16 inch, minimum and shall be manufactured by McNICHOLS, AMICO, Robertsons Grating Products, or approved equal.

2.02 MATERIALS

Nonstructural steel bars, angles, clips, and similar items - ASTM A36 or ASTM A283

Iron castings - ASTM A48

Structural steel tubing - ASTM A500, Grade B

Steel bolts (except flanges and anchor bolts) - ASTM A307, Grade A

Stainless steel - ASTM A320 Type 316

Welded stainless steel - ASTM A320 Type 316L

2.03 FABRICATION

- A. General. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise indicated. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled. No drifting of bolts nor enlargement of holes will be allowed to correct misalignment.

All cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent work shall be performed prior to hot-dip galvanizing. Field work shall not be permitted on galvanized items.

- B. Seat Angles, Supports and Brackets. Seat angles over slide gate guides shall be welded to the guides. Seat angles for grating, supports for floor plates, clips for precast panels and brackets for piping shall be steel, of sizes shown and shall be hot-dip galvanized after fabrication unless otherwise noted.
- C. Miscellaneous Steel Metalwork. All custom fabricated steel metalwork other than structural steel shall be considered miscellaneous steel metalwork. Miscellaneous steel metalwork including embedded and nonembedded steel metalwork, brackets, hangers and inserts shall be as indicated on the drawings. All miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General. Field work shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators as approved.

Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if shown or accepted, recesses or blockouts shall be formed in the concrete. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned of all rust, dirt, grease, loose scale, grout, mortar and other foreign matter. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

- B. Seat Angles, Supports and Guides. Seat angles for grating and supports for floor plates shall be set so that they are flush with the floor and also maintain the grating and floor plates flush with the floor.

3.02 CLEANING

- A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be cleaned and touched up with zinc dust-zinc oxide coating.

END OF SECTION 05 50 00

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section covers the carpentry work, material and accessories.

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PLYWOOD ASSOCIATION (APA)

APA AFG-01 Adhesives for Field-Gluing Plywood to Wood Framing
APA Form E30 Design/Construction Guide, Residential and Commercial

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307 Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength

AMERICAN WOOD PRESERVERS BUREAU

AWPB LP-2 Softwood Lumber, Timber & Plywood Preserve Treated with
Waterborn Preservatives for Above Ground Use

NATIONAL FOREST PRODUCTS ASSOCIATION (NFOPA)

NFOPA-01 National Design Specification for Wood Construction
NFOPA-02 Manual for Wood Frame Construction

TRUSS PLATE INSTITUTE (TPI)

TPI TPI-85 Design Specification for Metal Plate Connected Wood Trusses
TPI QST 88 Quality Standard for Metal Plate Connected Wood Trusses Addendum
to TPI-85

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01 Western Lumber Grading Rules

1.3 SUBMITTALS

- A. Structural and Miscellaneous Wood Members: Design analysis and calculations of fabricated wood trusses shall show design criteria used to accomplish the applicable analysis.
- B. Shop Drawings: Drawings of fabricated wood trusses shall indicate materials and shop and field erection details including methods of fastening.
- C. Manufacturer's Certificates: Manufacturer's certificates attesting that lumber and material not normally grade marked or exempt from being grade marked meets the specified requirements.

1.4 DELIVERY AND STORAGE

- A. Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2 PRODUCTS

2.1 LUMBER AND SHEATHING

- A. Grading and Marking: Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade species used. Except for plywood and lumber; bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.
- B. Sizes: Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.
- C. Trussed Rafters: Rafters shall be a prefabricated design. Connections shall be made with

light-metal plate-connectors. Light-metal-plate-connected wood trusses shall be designed in conformance with TPI TPI-85 and fabricated in conformance with TPI QST-88.

- D. Plywood: Plywood shall be APA performance rated, Grade C-D with exterior glue. Sheathing for roof without corner bracing of framing shall have a span rating of 16/0 or greater for supports 16 inches on center and a span rating of 24/0 or greater for supports 24 inches on center.
- E. Wood: Provide dressed lumber, S4S, unless otherwise indicated. Provide seasoned lumber with 19 percent maximum moisture. For structural framing use No. 2 grade Douglas-fir or Larch or any species or grade meeting the following requirements:
 - 1. F_b : 900 psi
 - 2. E : 1,600,000 psi

2.2 PRESERVATIVE TREATMENT

- A. The treatment of lumber, timber, and plywood shall meet the requirements of AWPB LP 2 for above ground use only. All products shall bear the appropriate AWPB Quality Mark. The wood shall then be dried to the moisture content specified and marked with the word "Dry." Surfaces of lumber that will be exposed shall not be incised. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPB M4. Unless otherwise specified the following items will always be treated:
 - 1. All wood members used in built-up roofing systems.
 - 2. All wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.
 - 3. All wood members used for rough framing of openings in exterior concrete or masonry walls.
 - 4. Nailing strips or nailers used in conjunction with roof systems.

2.3 ACCESSORIES AND NAILS

- A. Anchor Bolts shall conform to ASTM A 307, size as indicated, complete with nuts and washers.
- B. Expansion Shields shall be the Type and size best suited for intended use.
- C. Joist Hangers and Truss Clips shall be steel or iron, zinc-coated, size to fit members

where used, sufficient strength to develop the full strength of supported member, complete with any special nails required.

- D. Nails and Staples shall be of the size and type best suited for purpose. For sheathing, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1-inch thick lumber and for toe nailing 2-inch thick lumber; 16-penny or larger nails shall be used for nailing through 2-inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized.

PART 3 EXECUTION

3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS

- A. General: Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Nailing shall be in accordance with the recommended Nailing Schedule as contained in NFOPA-02. Where detailed nailing requirements are not specified, nail size and nail spacing shall be sufficient to develop an adequate strength for the connection without splitting the members. Installation of timber connections shall conform to applicable requirements of NFOPA-01. Members shall be framed for passage of ducts and pipes shall be cut, notched, or bored in accordance with applicable requirements of NFOPA-02. Rafters, purlins, and joists shall be set with crown edge up. Leveling of joists, beams, and girders on masonry or concrete shall be with slate or steel; on wood or metal leveling shall be without shims.
- B. Sill Plates: Sill plates shall be set level and square and anchor bolted at not more than 2 feet 8 inches on centers and not more than 12 inches from end of each piece. A minimum of two anchors shall be used for each piece.
- C. Roof Framing or Rafters: Tops of supports or rafters shall form a true plane. Valley, ridge, and hip members shall be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters. Valleys, hips, and ridges shall be straight and true intersections of roof planes. Necessary crickets and watersheds shall be formed. Rafters, except hip and valley rafters, shall be spiked to wall plate and to ceiling joists with no less than three 8-penny nails. Rafters shall be toe-nailed to ridge; valley, or hip members with at least three 8-penny nails. Rafters shall be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters shall be secured to wall plates by clip angles. Openings in roof shall be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter shall be double. Hip rafters longer than the available lumber shall be butt jointed and scabbed. Valley rafters longer than the available lumber shall be double, with pieces lapped not less than 4 feet and well spiked together. Trussed rafters shall be installed in accordance with TPI TPI-85.

- D. Blocking: Blocking shall be provided as necessary to meet the latest codes for lateral bracing and for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide fire stopping. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

3.2 INSTALLATION OF SHEATHING

- A. Plywood: Sheathing shall be applied with edges 1/8 inch apart at side and end joints, and nailed at supported edges at 6 inches on center and at intermediate supports 12 inches on center. Nailing of edges shall be 3/8 inch from the edges. Wall sheathing shall extend over top and bottom plates, and if applied horizontally the vertical joints shall be made over supports and staggered. Roof sheathing shall be applied with long dimension at right angles to supports, end joints made over supports, and end joints staggered.

- END OF SECTION -

SECTION 06 17 53
PREFABRICATED WOOD TRUSSES

PART 1 GENERAL

1.1 WORK INCLUDED

Design, manufacture, and supply wood trusses as shown on the Construction Documents and as specified.

1.2 DESIGN

- A. Trusses shall be designed in accordance with the Standard and where any applicable design feature is not specifically covered herein, design shall be in accordance with the applicable provisions of the latest edition of the American Forest & Paper Association's (AF&PA's) *National Design Specification (NDS) for Wood Construction* and all applicable Legal Requirements.
- B. Truss Manufacturer shall furnish Truss Design Drawings prepared in accordance with all applicable Legal Requirements.
- C. If required by the Construction Documents and the Truss Manufacturer's contract, the Truss Manufacturer shall furnish a Truss Placement Diagram which shall provide at a minimum the location assumed for each Truss based on the Truss Manufacturer's interpretation of the Construction Documents.
- D. Where required by the Truss Manufacturer's contract, any local building official or applicable legal requirements, the Truss Manufacturer shall submit the Truss Submittal Package to the Building Designer and/or the local Building Official for review and approval prior to the manufacturing of the Trusses.
- E. The Truss Design Drawings shall include, at a minimum, the information specified below (per the Standard):
 - 1. Building Code used for Design, unless specified on Cover/Truss Index Sheet.
 - 2. Slope or depth, span and spacing.
 - 3. Location of all joints and support locations.
 - 4. Number of plies if greater than one.
 - 5. Required bearing widths.
 - 6. Design loads as applicable, including:
 - a. Top Chord live load (for roof Trusses, this shall be the controlling case of live load or snow load);
 - b. Top chord dead load;
 - c. Bottom chord live load;
 - d. Bottom chord dead load;

- e. Additional loads and locations;
 - f. Environmental Load Design Criteria (wind speed, snow, seismic, and all applicable factors as required to calculate the Truss loads); and
 - g. Other lateral loads, including drag strut loads.
7. Adjustments to Wood Member and Metal Connector Plate design values for conditions of use.
 8. Maximum reaction force and direction, including maximum uplift reaction forces where applicable.
 9. Metal Connector Plate type, manufacturer, size, and thickness or gauge, and the dimensioned location of each Metal Connector Plate except where symmetrically located relative to the joint interface.
 10. Size, species and grade for each Wood Member.
 11. Truss-to-Truss connection and Truss field assembly requirements.
 12. Calculated span to deflection ratio and/or maximum vertical and horizontal deflection for live and total load and K_{CR} (creep factor) as applicable.
 13. Maximum axial tension and compression forces in the truss members.
 14. Fabrication tolerance per the Standard.
 15. Required Permanent Individual Truss Member Restraint location and the method of Restraint/Bracing to be used per the Standard.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber:

1. Lumber used shall be identified by grade mark of a lumber inspection bureau or agency approved by the American Lumber Standards Committee, and shall be the size, species, and grade as shown on the Truss Design Drawings, or equivalent as approved by the Truss Design Engineer/ Truss Designer.
2. Adjustment of value for duration of load or conditions of use shall be in accordance with *NDS*.
3. Fire retardant treated lumber, if applicable, shall meet the specifications of the fire retardant chemical manufacturer, the Truss design and the Standard and shall be re-dried after treatment in accordance with the American Wood-Preservers' Association (AWPA) Standard *C20 Structural Lumber – Fire Retardant Treatment by Pressure Processes*. Allowable values must be adjusted in accordance with *NDS*. Lumber treater shall supply certificate of compliance.

B. Metal Connector Plates:

1. Metal connector plates shall be manufactured by a Truss Plate Institute (TPI) member plate manufacturer and shall not be less than 0.036 in. thick (20 gauge)

and shall meet or exceed *ASTM A653/A653M* grade 33, and galvanized coating shall meet or exceed *ASTM A924/924M*, coating designation G60. Working stresses in steel are to be applied to effectiveness ratios for plates as determined by test and in accordance with the Standard.

2. In highly corrosive environments, special applied coatings or stainless steel may be required.
3. At the request of the Building Designer, a TPI member plate manufacturer shall furnish a certified record that materials comply with steel specifications.

2.2 MANUFACTURING

- A. Trusses shall be manufactured to meet the quality requirements of the Standard and in accordance with the information provided in the final approved Truss Design Drawings.

PART 3 EXECUTION

3.1 HANDLING, INSTALLING, RESTRAINING AND BRACING

- A. Trusses shall be handled during manufacturing, delivery and by the Contractor at the job site so as not to be subjected to excessive bending.
- B. Trusses shall be unloaded in a manner so as to minimize lateral strain. Trusses shall be protected from damage that might result from on-site activities and environmental conditions. Trusses shall be handled in such a way so as to prevent toppling when banding is removed.
- C. Contractor shall be responsible for the handling, installation, and temporary restraint/bracing of the Trusses in a good workmanlike manner and in accordance with the recommendations set forth in the latest edition of *BCSI*.
- D. Apparent damage to Trusses, if any, shall be reported to Truss Manufacturer prior to erection.
- E. Trusses shall be set and secured level and plumb, and in correct location. Each Truss shall be held in correct alignment until specified permanent restraint and bracing is installed.
- F. Cutting and altering of Trusses is not permitted. If any Truss should become broken, damaged, or altered, written concurrence and approval by a Registered Design Professional is required.
- G. Concentrated loads shall not be placed on top of Trusses until all specified restraint and bracing has been installed and decking is permanently nailed in place. Specifically avoid stacking full bundles of plywood or other concentrated loads on top of Trusses.
- H. Truss Submittals and any supplementary information provided by the Truss Manufacturer shall be provided by the Contractor to the individual or organization responsible for the installation of the Trusses.
- I. Trusses shall be permanently restrained and braced in a manner consistent with good building practices as outlined in *BCSI* and in accordance with the requirements of the Construction Documents. Trusses shall furthermore be anchored or restrained to prevent

out-of-plane movement so as to keep all Truss members from simultaneously buckling together in the same direction. Such permanent lateral restraint shall be accomplished by: (a) anchorage to solid end walls; (b) permanent diagonal bracing in the plane of the web members; or (c) other suitable means.

- J. Materials used in temporary and permanent restraint and bracing shall be furnished by Contractor.

- END OF SECTION -

**SECTION 07 11 00
MOISTURE PROTECTION**

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section provides specifications for damp proofing of below-grade concrete surfaces in the tank vault as shown on the plans.

1.2 REFERENCES

- A. ASTM D450, Standard for coal tar pitch.

1.3 SUBMITTALS

- A. Submittals shall state manufacturer's specifications, product data, installation instructions and indicate suitability for usage in the locations of the vault. Submittals shall be in accordance with Section 01 33 00.

PART 2 PRODUCTS

2.1 MOISTURE PROOF COATING

- A. Moisture proof coating shall be coal tar solution. Products shall be Engard 800 High Build Coal Tar Coating, Koppers Super Service Black, Porter Tarmactic 103 or an OWNER approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Moisture proof coating shall be applied below grade, earth side of concrete walls.
- B. Surface Preparation. Preparation of concrete and masonry walls shall conform to manufacturer's recommendations.
- C. Prime and finish coats shall be applied at the rate of 70 square feet per gallon. The number of finish coats shall be sufficient to produce a dry film thickness of at least 13 mils. Drying time between coats shall be as recommended by the manufacturer.

END OF SECTION 07 11 00

SECTION 07 21 00
INSULATION

PART 1 GENERAL

1.1 DELIVERY, STORAGE, AND HANDLING

- A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.
- B. Store materials off ground and keep them dry at all times. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.1 BATT INSULATION AND FASTENERS

- A. Fiberglass or Mineral Wool Batts: ASTM C665, Type III, Class A, with 0.5 perm. rating, reflective aluminum foil vapor retarder membrane laminated to one side with R-values as indicated on Drawings.
 - 1. Widths: As required by framing spacing.
 - 2. Manufacturers:
 - a. Manville.
 - b. Owens-Coming Fiberglas Corp.
 - c. U.S. Gypsum.
 - d. Certainteed.
- B. Fasteners: Galvanized flattened steel staples with 7/16-inch minimum crown and 2-inch minimum shank.

2.2 MASONRY FILL INSULATION

- A. Perlite Water Repellent Loose Fill: ASTM C549.
- B. Vermiculite Water Repellent Loose Fill: ASTM C516, Type II.

2.3 RIGID INSULATION

- A. Extruded polystyrene foam, ASTM C578, Type IV.
- B. Thickness as shown.
- C. Manufacturers and Products

1. Dow Chemical Co.; Square Edge.
2. UC Industries: Formular.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Batt Insulation: Locate and install as indicated and in accordance with manufacturer's instructions, except as specified below:
 1. Install faced batt insulation with vapor retarder facing warm side.
 2. Fit tightly to ensure continuous seal.
 3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.
 4. Protect installed insulation from tears and other damage until covered with finish material.
 5. Remove and replace damaged material.

3.2 MASONRY FILL INSULATION

- A. Pours shall not exceed 20 feet.
- B. Do not rod or tamp.
- C. Do not pour into cavity.

3.3 RIGID INSULATION

- A. Install where indicated and in thicknesses shown.
- B. Butt edges tight, cut with saw, knife, or other sharp tool to fit tightly around obstructions.

- END OF SECTION -

SECTION 07 31 13
ASPHALT SHINGLES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Contractor shall furnish and install asphalt roofing shingles, metal flashing, metal fascia and soffit panels, leak barrier and roof deck underlayment, system support framing, and appurtenant work, complete and in place.
- B. The principal items of sheet metal work included in the asphalt shingle roofing shall include sheet metal flashing, covers, trim, enclosure batts, collars and sleeves at all roof penetrations, metal soffit panels, and all other sheet metal items necessary for a complete and watertight asphalt shingle roofing system.

1.2 RELATED WORK

- A. Related work in other sections includes but is not limited to:
 - 1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
 - 1. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 2. ASTM D 1079 Standard Terminology Relating to Roofing and Waterproofing
 - 3. ASTM D 3018 Standard Specification for Class A Asphalt Shingles Surfaced with Mineral Granules
 - 4. ASTM D 3161 Standard Test Method for Wind-Resistance of Asphalt Shingles (Fan-Induced Method)
 - 5. ASTM D 3462 Standard Specification for Asphalt Shingles Made From Glass Felt and Surfaced with Mineral Granules
 - 6. ASTM D 4586 Standard Specification for Asphalt Roof Cement, Asbestos-Free
 - 7. ASTM D 7158 Standard Test Method for Wind-Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)
 - 8. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

C. UNDERWRITERS LABORATORY (UL)

1. UL 580	Test for Uplift Resistance of Prepared Roof Assemblies
2. UL 790	Tests for Fire Resistance of Roof Covering Materials
3. UL 997	Wind Resistance of Prepared Roof Covering Materials

D. AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

1. AAMA 1402	Standard Specifications for Aluminum Siding, Soffit, and Fascia

1.4 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D1079 and the glossary of the National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual for definitions of roofing terms related to this section.

1.5 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit detailed shop drawings showing materials, gages, finishes, layout, corners, trim, flashing, enclosures, edge conditions, jointing, profiles, supports, fasteners, fabrication of special shapes, and method of attachment to adjacent construction to Engineer prior to fabrication. Submit drawings indicating roof size, location and type of penetrations, perimeter and penetration details, roof insulation make-up and sheet layout that have been accepted by an authorized manufacturer's representative.
- C. Submit manufacturer's literature indicating materials, finish, construction, and method of installation of prefabricated items and sealant.
- D. Provide color samples for color selection by OWNER.
- E. Submit the following test reports, certified by an Independent Testing Laboratory or a professional engineer registered in the State of Utah to verify the proposed roofing will meet performance requirements of this Specification:
1. Thermal Cycle Test
 2. ASTM E-330 Adapted to Test Formed Metal Panels
 3. Clip Fastener Pull-Out Tests and Calculations
 4. UL 580 Class 90
 5. Concentrated Load Test Data
 6. Air Infiltration (E-283) and Water Penetration (E-331) Test Results
 7. Coating Performance Testing
- F. Submit certification by the manufacturer that the roofing assembly is listed in the UL Building Materials Directory with a Class 1-90 wind uplift rating, including relevant construction number.

1.6 WARRANTIES

- A. Roofing manufacturer shall provide written 30-year material and labor warranty beginning at the date of final acceptance.
- B. CONTRACTOR shall provide to OWNER written warranty that the roof system is installed in accordance with the manufacturer's recommendations and will be free from defective workmanship and remain watertight and weatherproof with normal usage for two (2) years following Project Substantial Completion date.

1.7 QUALITY ASSURANCE

- A. A single installer shall perform the work of this Section and shall have completed projects of similar scope and complexity.
- B. Provide all primary roofing products, including shingles, underlayment, leak barrier, and ventilation, by a single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store all products in manufacturer's unopened, labeled packaging until they are ready for installation.
- B. Store products in a covered, ventilated area, at temperature not more than 110 degrees F (43 degrees C); do not store near steam pipes, radiators, or in direct sunlight.
- C. Store bundles on a flat surface. Maximum stacking height shall not exceed the manufacturer's recommendations. Store all rolls on end.
- D. Store and dispose of solvent-based materials in accordance with all federal, state and local regulations.

1.9 ENVIRONMENTAL CONDITIONS

- A. Do not install ice dam membrane and shingles when surface temperatures are below 45 degrees F (7 degrees C).

1.10 SEQUENCING

- A. Install roofing system only after installation of metal fascia. Install underlayment and formed valley metal in valleys after installation of general secondary underlayment, but before installation of general primary underlayment.

PART 2 PRODUCTS

2.1 SHINGLES

- A. Self-sealing, granule surfaced, asphalt shingle with a strong fiberglass reinforced core and stain protection, which prevents pronounced discoloration from blue-green algae

through formulation/unique blends of granules. Architectural laminate styling provides a wood shake appearance with a 5 5/8 inch exposure. Features high definition color blends and enhanced shadow effect. UL 790 Class A rated with UL 997 Wind Resistance Label; ASTM D 7158, Class H; ASTM D 3161, Type 1; ASTM D 3018, Type 1; ASTM D 3462; AC438; CSA A123.5-98; ICC Report Approval. Asphalt shingles shall be Timberline HD Lifetime High Definition Shingles by GAF, Heritage by TAMKO, or approved equal.

- B. Color shall be selected by the OWNER from the manufacturer's standard colors.

2.2 STARTER STRIP

- A. Self-sealing starter shingle designed for all roof shingles. Starter strip shall be ProStart Starter Strip by GAF, TAMKO Shingle Starter, or approved equal.

2.3 LEAK BARRIER

- A. Leak Barrier shall be a cold applied, self-adhering membrane composed of high strength polyethylene film coated with a layer of rubberized asphalt adhesive and interwound with a disposable release sheet. An embossed lip resistant surface is provided on the polyethylene. Color shall be black. Membrane thickness shall be 40 mil minimum. Underlayment shall be UL 790 listed Class A fire classification under fiber-glass shingles and Class C under organic felt shingles. Leak Barrier shall be Ice and Water Shield by Grace Construction Products, Moisture Guard Plus by TAMKO, or approved equal.

2.4 ROOFING UNDERLAYMENT

- A. #30 Roofing Underlayment - Water repellent breather type cellulose fiber building paper. Meets or exceeds the requirements of ASTM D-4869 Type II.

2.5 ROOFING CEMENT

- A. Asphalt Plastic Roofing Cement meeting the requirements of ASTM D 4586, Type I or II.

2.6 ATTIC VENTILATION

- A. Ridge Vents
 - 1. Flexible rigid plastic ridge ventilator designed to allow the passage of hot air from attics, while resisting snow infiltration. Ridge vents shall be for use in conjunction with eave/soffit ventilation products. Provides 12.5 sq inches Net Free Ventilation Area per lineal foot. Ridge vent shall be Cobra Ridge Runner by GAF, Coolridge or Xtractor Vent XLP Turbo by TAMKO, or approved equal.

2.7 METAL FLASHING

- A. Metal flashing shall be 24 gauge hot-dip galvanized steel sheet, complying with ASTM A 653, G90/Z275.

2.8 FASCIA AND SOFFIT SYSTEM

- A. Fascia, soffit, J-Channel, and trim shall be fabricated from aluminum 3105 or equivalent alloy. Fascia shall have a nominal thickness of 0.024 inch and soffit nominal thickness shall be 0.019 inch. Materials shall meet the requirements of AAMA 1402. Soffit shall 12 inches wide and perforated with a net free area of at least 8 square inches/foot.
- B. Finish shall be a baked-on enamel. Color shall be as selected by the OWNER.
- C. Nails and screws shall be stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until the roof deck has been properly prepared.
- B. Verify proper placement of all roof openings, pipes, curbs, sleeves, ducts, vents and drains.

3.2 SUBSTRATE PREPARATION

- A. Comply with manufacturer's instructions for preparation of substrate to receive roofing. Clean substrate of dust, debris and other substances detrimental to the roofing work. Verify the roof deck is free of any depressions, waves, and projections. Cover with sheet metal all holes over 1-inch in diameter and cracks over 1/2-inch in width. Replace damaged deck with new materials.

3.3 INSTALLATION OF UNDERLAYMENT

- A. General: Install underlayment using methods recommended by the manufacturer and in accordance with local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.
- B. Eaves: Install eaves with metal flashing tight with fascia boards. Lap joints 2 inches and seal with plastic cement or high quality urethane sealant. Nail at the top of the flange. Install leak barrier up slope from eaves edge a full 36 inches or to at least 24 inches beyond the interior "warm wall". Lap ends of leak barrier at least 6 inches.
- C. Valleys: Install leak barrier at least 36 inches wide and centered on the valley. Lap ends at least 6 inches.
- D. Hips and Ridges: Install leak barrier along entire lengths. If ridge vents are to be installed, position leak barrier so that the ridge slots will not be covered.
- E. Roof Deck: Install on layer of roof underlayment over the entire area not protected by leak barrier. Install sheets horizontally so water sheds and nail in place. On roofs sloped more than 4:12 lap horizontal edges at least 2 inches and at least 2 inches over leak barrier. For roofs sloped between 2:12 and 4:12, lap horizontal edges at least 19 inches

and at least 19 inches over leak barrier. Lap ends at least 4 inches and stagger ends laps at least 36 inches. Lap roof underlayment at least 6 inches over leak barrier in valley.

F. Penetrations

1. Vent Pipes: Install a 24 inch square piece of leak barrier lapping over roof underlayment and seal tightly to pipe.
2. Skylights: Install leak barrier membrane extending at least 6 inches up the wall and 12 inches on to the roof surface. Lap the membrane over the roof deck underlayment.

3.4 INSTALLATION OF STARTER SHINGLES

A. General: Install in accordance with the manufacturer's instructions and local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.

B. Placement and Nailing

1. For maximum wind resistance along rakes and eaves, install starter strip containing sealant or cement shingles to underlayment and each other in a 4 inch width of asphalt plastic roof cement.
2. Place starter strip shingles over eave and rake edges to provide drip edge.
3. Nail approximately 1-1/2" to 3" above the butt edge of the shingle.
4. Rake starter course should overlap eave edge starter strip at least 3 inches.

3.5 INSTALLATION OF SHINGLES

A. General: Install in accordance with the manufacturer's instructions and local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.

B. Placement and Nailing

1. Secure with 4, 5, or 6 nails per shingle per manufacturer's instructions or local codes.
2. Placement of nails varies based on the type of shingle specified. Consult the application instructions for the specified shingle for details.
3. Nails must be driven flush with the shingle surface. Do not overdrive or underdrive the nails.
4. Shingle offset varies based on the type of shingle specified. Consult the application instructions for the specified shingle for details.

- C. Penetrations: All penetrations are to be flashed according to ARMA and NRCA application instructions and construction details.
- D. Skylights: Consult the manufacturer of the skylight for specific installation recommendations. Skylights shall be installed with pre-fabricated metal flashings specifically designed for the unit. See Section 08 62 00 – Skylights for additional requirements.

3.6 INSTALLATION OF ATTIC VENTILATION

- A. General: Ventilation must meet or exceed the current FHA, HUD, or local code requirements.
- B. Ridge Ventilation
 - 1. Install ridge vent along the entire length of ridges
 - 2. Cut continuous vent slots through the sheathing, stopping 6 inches from each end of the ridge.
 - 3. Install ridge vent material along the full length of the ridge, including uncut areas.
 - 4. Butt ends of ridge vent material and joint using roofing cement.

3.7 INSTALLATION OF FASCIA AND SOFFIT

- A. Install fascia and vented soffit according to the manufacturer's written instructions.

- END OF SECTION –

SECTION 07 62 00
SHEET METAL FLASHING AND SIDING SYSTEM

PART 1 GENERAL

1.1 SUBMITTALS

- A. Shop Drawings:
 - 1. Show joints, types and location of fasteners, and special shapes.
 - 2. Catalog data for stock manufactured items.
- B. Samples: Color samples for items to be factory finished.

1.2 DELIVERY, HANDLING, AND STORAGE

- A. Package and protect during shipment.
- B. Inspect for damage, dampness, and wet storage stains upon delivery to the Work site.
- C. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.
- D. Carefully handle to avoid damage to surfaces, edges, and ends.
- E. Do not open packages until ready for use.
- F. Store materials in dry, weather tight, ventilated areas until immediately before installation.

1.3 SPECIAL GUARANTEE

- A. Product: Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the OWNER, removal and replacement of factory-applied fluoropolymer coating, finish, and accessories found defective during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal a replacement of defective Work shall be as specified in the General Conditions.
- B. Conditions:
 - 1. Finish: No cracking, blistering, flaking, chipping, checking, chalking peeling, or fading.
 - 2. All Components: Watertight and weather-tight with normal usage.

PART 2 PRODUCTS

2.1 METAL FLASHING

- A. Aluminum Sheet: ASTM B209, Alloy 5005-H34, 0.032-inch thick, unless otherwise shown.
- B. Galvanized Sheet Steel: ASTM A525 and ASTM A526, G90, commercial quality copper bearing steel, thickness 0.0217-inch (26 U.S. Standard gauge), unless otherwise shown.
- C. Pre-finished Metal: Aluminum, ASTM B209, Alloy 3003H-16, 0.032-inch thick, with Polyvinylidene Fluoride (Kynar 500) 1.0 plus or minus 0.1 mil thickness with 0.3 mil wash coat on reverse side.

2.2 DOWNSPOUTS, GUTTERS, SCUPPERS, AND CONDUCTOR HEADS

- A. Use prefinished metal.

2.3 ANCILLARY FLASHING MATERIALS

- A. Solder: ASTM B32, alloy composition Sn 50.
- B. Soldering Flux: ASTM B32, Type RA.
- C. Sealer Tape: Polyisobutylene sealer tape.
- D. Isolation Paint: ASTM D 1187, asphalt.
- E. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.
- F. Plastic Roof Cement: ASTM D4586, Type 111.
- G. Fasteners:
 - 1. For Galvanized Steelwork: Steel, galvanized per ASTM A 153 or stainless steel fasteners.
 - 2. For Aluminum Work: Stainless steel or aluminum; reglet fasteners may be galvanized or cadmium-plated steel.
 - 3. Nails: Roofing nailhead, 10-gauge spiral or ring shank, lengths as required to penetrate wood at least 3/4-inch.
 - 4. Pre-finished Metal: Color match, prefinished heads.

2.4 FABRICATION OF FLASHING

- A. Field measure prior to fabrication.

- B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.
- C. Accurately form flashings to shapes shown and detailed, with angles and lines in true alignment.
- D. Form arris and angles true to line and surfaces free of waves and buckles.
- E. Form bends to 1/1 6-inch inside radius.
- F. Hem exposed edges.
- G. Reinforcements and Supports: Provide same material as flashing unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.
- H. Rigid Joints and Seams: Make mechanically strong. Seal aluminum joints with sealant. Solder galvanized and stainless steel metal joints. Do not use solder to transmit stress.
- I. Fabricate sheet metal in 10-foot maximum lengths, unless otherwise indicated.
- J. At exposed ends of counterflashing furnish weathertight closures.
- K. Fabricate comers in one-piece with legs extending 30 inches each way to field joint. Lap, rivet, and solder comer seams watertight.
- L. Neutralize soldering flux.
- M. Solvent clean sheet metal. Surfaces to be in contact with roofing or otherwise concealed shall be coated with isolation paint.

2.5 FABRICATION OF DOWNSPOUTS, GUTTERS, SCUPPERS, AND CONDUCTOR HEADS

- A. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.
- B. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on Drawings.
- C. Telescope end joints 1- 2inches and lock longitudinal joints of downspouts.
- D. Furnish elbows at bottom where downspouts empty onto splash blocks.

2.6 METAL SIDING AND FASCIA FLASHING SYSTEMS

- A. Metal: 3105 aluminum sheet with minimum tensile strength of 27,000 psi and

minimum yield strength of 26,000 psi.

- B. System: Meet requirements per AAMA 1402. Provide all accessories for a complete, weathertight installation.
- C. Finish: Kynar 500.
- D. Color: To be selected from manufacturer's standards.
- E. Manufacturer and Products:
 - 1. Alcoa Building Products, Sidney, OH.
 - 2. Siding: Horizon Double 5 inch.
 - 3. Soffit: Tranditional Select (0.019-inch) Double 6-inch, perforated.
 - 4. Fascia Flashing: Traditional Select, size as required.
 - 5. Attic Vent Louver: Siding manufacturer's standard rectangular gable vent with insect screen.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Flashing:
 - 1. Coordinate flashing Work with roofing Work for weathertight and watertight assembly.
 - 2. Isolate metal from wood and concrete and from dissimilar metal with isolation tape or two coats of isolation paint.
 - 3. Use only stainless steel fasteners to connect isolated dissimilar metals.
 - 4. Joints: 10-foot maximum spacing and 2-1/2 feet from corners, butted with 3/16-inch space centered over matching 8-inch long backing plate with sealer tape in laps.
 - 5. Set flanges of flashings and roof accessories on continuous sealer tape or in plastic roof cement on top of envelope ply of roofing. Nail flanges through sealer tape and at 3-inch maximum spacing. Touch up isolation paint on flanges.
 - 6. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.
 - 7. Provide continuous holddown clips at counterflashing and gravel stops.
 - 8. Conceal fastenings wherever possible.
 - 9. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.
- B. Downspouts, Gutters, Scuppers, and Conductor Heads: Anchor downspouts to wall with straps of same material as downspouts. Install gutters, scuppers, and conductor heads as indicated on Drawings.

- C. Metal Siding and Fascia Flashing: Siding, soffit, fascia, trim, and accessories shall be installed in strict accordance with the manufacturer's printed instructions and recommendations.

3.2 FINISH

- A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

- END OF SECTION -

**SECTION 08 30 00
ACCESS HATCHES**

PART 1 GENERAL

1.1 SUMMARY

A. This section covers all the work necessary to furnish and install all hatches.

1.2 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. A 229 Steel Wire, Oil-Tempered for Mechanical Springs
3. A 366 Cold Rolled Steel
4. A 525 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

1.3 DESIGN REQUIREMENTS

A. Any hatch in a roadway or located where traffic may drive over the hatch shall be designed to meet H-20 highway wheel loading.

B. Hatches for the wet well vault shall be designed to handle loadings of 150 lbs per sq. foot.

1.4 SUBMITTALS

A. Manufacturer's catalog data and preprinted installation instructions of hatches.

B. A schedule showing the location of each hatch shall be included with the drawings. Submittal drawings shall include details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

1.5 DELIVERY AND STORAGE

A. Hatches shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon.

1.6 WARRANTY

- A. Manufacturer shall provide to COMPANY written guarantee against defects in material or workmanship for a period of five (5) years.

PART 2 PRODUCTS

2.1 HATCHES AND ACCESS DOORS

- A. Hatches or access doors shall be as noted on the drawings and meet the requirements specified herein. Approved equals will be allowed. All hardware shall be stainless steel throughout. Each hatch shall be provided with a permanent label showing the manufacturer's name and address and the model number. Hatches shall have stainless steel hold open arm with positive locking.
- B. Hatches or access doors shall be aluminum in corrosive conditions or environments and steel or aluminum as noted in all other areas. Aluminum frames to be cast in concrete shall be mill finished with a bituminous coating applied to the exterior of the frame. All hardware shall be stainless steel throughout.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Hatches shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, hatches shall be weather tight and shall be free from warp, twist, or distortion. Hatches shall be lubricated, properly adjusted, and demonstrated to operate freely.

- END OF SECTION -

SECTION 08 31 13
METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section covers all the work necessary to furnish and install all doors.
- B. All doors and their pressed steel frames shall be steel, insulated, exterior, 1 3/4-inch doors of the dimensions in drawings.

1.2 RELATED WORK

- A. Related work in other sections includes but is not limit to:

Section 09 91 00 - Painting and Finishes

1.3 REFERENCES

- A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A 224.1 Test Procedure and Acceptance Criteria for Prime Painted Steel
Surfaces for Steel Doors and Frames

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 229 Steel Wire, Oil-Tempered for Mechanical Springs
ASTM A 366 Cold Rolled Steel
ASTM A 525 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM C 177 Thermal Properties
ASTM D 256 Impact Resistance
ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time
of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 790 Flexural Strength
ASTM D 792 Density/Specific Gravity of Laminate
ASTM D 882 Tensile Strength
ASTM D 1622 Density/Specific Gravity
ASTM D 2583 Barcol Hardness
ASTM D E 84 Surface Burning Characteristics
ASTM E 84 Standard Test Method for Surface Burning Characteristics of
Building Materials
ASTM E 330 Structural Performance of Exterior Windows, Curtain Walls,

1.4 SUBMITTALS

- A. Manufacturer's catalog data and preprinted installation instructions of doors.
- B. A schedule showing the location of each door shall be included with the drawings. Submittal drawings shall include elevations of each door type, details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

1.5 DELIVERY AND STORAGE

- A. Doors shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

PART 2 PRODUCTS

2.1 ACCESS DOORS

- A. Access doors and frames shall be made of prime quality, cold rolled, pickled annealed, stretcher leveled steel free from scale, pitting and surface defects and shall conform to the following:
 - 1. Hollow metal door, 1 3/4 inches thick flush type, constructed of two sheets of not less than 18-gauge steel sheets formed and welded for flush pan assembly, with internal 20-gauge vertical reinforcing channels spaced not over 8 inches on centers the full height of the door. There shall be no visible joints on the face of the doors. Reinforcing channels shall be uniformly spot welded to face plates at top and bottom of all doors. Filler channels shall be provided at the top and bottom of doors to provide a flush closure.
 - 2. All interior void spaces shall be completely filled with not less than 3 pound density rock wool or polyurethane.
 - 3. Concealed sheet or bar steel reinforcement shall be provided for mortise type hardware. Reinforcing shall not be less than the following: 9-gauge for butts, 12-gauge for locksets and 14-gauge for surface applied hardware. Reinforcing shall be drilled and tapped to template requirements. Concealed reinforcing shall be provided for closures. Door bottom weatherstripping shall be included to match thresholds.
 - 4. Door frames shall be pressed steel constructed of not less than 16-gauge steel and shall be of the shape indicated on the plans and as required to fit the various wall

constructions. Frames shall be of welded unit construction assembled and welded in the shop. Welding shall be to a hairline joint with all exposed beads ground smooth.

5. Concealed reinforcing of the frames for the mortise hardware shall be not less than the following: 3/16 inch for butts, 12- gauge for lock strike, 14-gauge for surface applied items and 18-gauge for plaster guards over mortised hardware reinforcement. Frames shall be mortised drilled, and tapped to template requirements. Lock reinforcing units shall be supplied by finishing hardware supplier. Frames shall be anchored as shown in the drawings.
6. Hinges shall be heavy duty ball bearing hinges with non-removable pins.
7. Door shall be equipped with a cylinder lock (in place of door knobs).
CONTRACTOR shall furnish OWNER with five (5) sets of cylinder lock keys.
8. Hardware including locksets and hinges shall be stainless steel.

B. Door Hardware:

1. Lever: Schlage ND80PD 626 or equal.
2. Dead Bolt: Schlage B660P 626 or equal.
3. Hinge: Hager BB1279 4-1/2 x 4-1/2 26D or equal (3 required per door).
4. Door Sweep: Pemko 315 or equal.
5. Threshold: Pemko 151A or equal.
6. Door stop: Hager No. 236W or equal.
7. Door frame: 16 ga, galvanized frame, welded, 8-3/4" wrap style, wire masonry anchors.
8. Lock Set: Locks must be compatible with Owners existing keys. Contractor shall verify that lock sets and keys will match Owner's requirements.

2.2 FABRICATION OF ACCESS DOORS AND FRAMES

- A. Fabricate doors and frames as shown on the drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance and free from defects. Field measurements shall be taken as required for coordination with adjoining work.
- B. Form exposed surfaces free from warp, wave and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.
- C. Reinforce members and joints with plates, tubes or angles for rigidity and strength.
- D. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer's instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.
- E. Mortar guard boxes shall be provided for hardware cutouts in frames.
- F. Furnish at least three (3) metal anchors or polymer spacers in each jamb of frames up to 84" high and one (1) additional anchor for each 24" in height above 84", in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction. Fabricate joint anchor of stainless steel.

- G. Terminate bottom of frames at the indicated finished floor level.
- H. Provide clearance for doors of 1/8" at jambs and heads; 1/4" clearance above threshold.
- I. Where glazing is required, flush integral stops on one side and screw-on stops on the opposite side shall be provided.

2.3 FINISH

- A. Surfaces shall be provided with a shop-primed galvanized finish. Prior to receiving primer, all surfaces shall be cleaned thoroughly and phosphate-treated to assure maximum paint adherence. Primer shall be a metallic oxide or synthetic resin primer of the manufacturer's standard type and shall be applied by dipping or spraying in accordance with ANSI A 224.1.
- B. Painting of doors and frames shall be in accordance with Section 09 91 00.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be weather tight and shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.
- B. Access Door Frame Installation
 - 1. Place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Frame must not be drilled for brace supports as finish may be damaged.
 - 2. Locate three (3) wall anchors per jamb at hinge and strike levels. Frames may be grouted full of mortar at jambs and anchors shall be built into the joints as walls are laid up. A continuous bead of silicone sealant is to be applied between the head and jamb at the miter joint.

END OF SECTION

SECTION 09 91 00
PAINTING AND FINISHES

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section covers furnishing, surface preparation, and applying paints and coatings, complete and in place, to all specified surfaces including exposed valves, piping or fittings.
- B. Definitions
 - 1. The term “paint”, “coatings”, or “finishes” as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
 - 2. The term “DFT” means minimum dry film thickness, without any negative tolerance.
 - 3. The term “mil” means thousandths of an inch.
 - 4. The term “SSPC” means The Society for Protective Coatings.
- C. The following surfaces shall not be coated:
 - 1. Concrete, unless otherwise required herein or on the Drawings.
 - 2. Stainless steel
 - 3. Machined surfaces
 - 4. Grease fittings
 - 5. Glass
 - 6. Equipment nameplates
 - 7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.
- D. The protective coatings applicator (Applicator) shall possess a valid state license as required for the performance of the painting and coating work called for in this specification and shall provide 5 references which show the Applicator has previous successful experience with the indicated of comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the Applicator provided the protective coating.

1.2 REFERENCES AND STANDARDS

- A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:
 - 1. OSHA Occupation Safety and Health Act: State of Utah and Federal

2. ICRI International Concrete Repair Institute Guideline No. 310.2 –
Selecting and Specifying Concrete Surface Preparation for
Sealers, Coatings, and Polymer Overlays

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI A 13.1 Standard for Scheme for the Identification of Piping Systems
2. ANSI Z 535 Standard for Safety Colors

C. AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

1. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on
Iron and Steel Products.
2. ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds
for Curing Concrete
3. ASTM D 6943 Standard Practice for Immersion Testing of Industrial Protective
Coatings Linings
4. ASTM D 1653 Standard Test Methods for Water Vapor Transmission of Organic
Coating Films
5. ASTM D 2370 Standard Test Method for Tensile Properties of Organic Coatings
6. ASTM D 2794 Standard Test Method for Resistance of Organic Coatings to the
Effects of Rapid Deformation (Impact)
7. ASTM D 4263 Standard Test Method for Indicating Moisture in Concrete by the
Plastic Sheet Method
8. ASTM D 4414 Standard Practice for Measurement of Wet Film Thickness by
Notch Gages
9. ASTM D 4417 Standard Test Methods for Field Measurement of Surface Profile
of Blast Cleaned Steel
10. ASTM D 7234 Standard Test Method for Pull-Off Adhesion Strength of Coatings
on Concrete Using Portable Pull-Off Adhesion Testers
11. ASTM D 7682 Standard Test Method for Replication and Measurement of
Concrete Surface Profiles Using Replica Putty
12. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials
13. ASTM F 1869 Standard Test Method for Measuring Moisture Vapor Emission
Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
14. ASTM F 2170 Standard Test Method for Determining Relative Humidity in
Concrete Floor Slabs Using in situ Probes

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 210 Liquid Epoxy Coating Systems for the Interior and Exterior of
Steel Water Pipelines
2. AWWA C 222 Polyurethane Coatings for the Interior and Exterior of Steel Water
Pipe and Fittings

E. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 301 Specifications for Structural Concrete

F. NACE International (NACE)

1. NACE RP0287 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE SP0892 Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service
4. NACE No. 1/SSPC-SP 5 White Metal Blast Cleaning
5. NACE No. 6/SSPC-SP13 Surface Preparation of Concrete

1.3 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- B. CONTRACTOR shall supply shop drawings for approval on all paint materials at least 30 days prior to installation. Submittals shall include the following data sheets:
 1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.
- C. Where ANSI/NSF 61 approval is required, submit ANSI/NSF 61 certification letter for each coating in the system indicating the product application limits on size of tank or piping, dry film thickness, number of coats, specific product tests, colors certified, and approved additives.
- D. Quality Control Submittals:
 1. Furnish a list of references for the Applicator substantiating the requirements as specified.
 2. Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
 3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers' written confirmation that materials are compatible.

1.4 PAINT DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.
- B. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the manufacturer.

1.5 QUALITY ASSURANCE

- A. All inspection for quality assurance shall ultimately be the responsibility of CONTRACTOR. OWNER retains the right to observe, accept, or reject the work based on the results of CONTRACTOR's inspection or observations by ENGINEER, at OWNER's discretion, in accordance with the specifications.
- B. Repair and recoat all runs, overspray, roughness, or any other signs of improper application in accordance with paint manufacturer's instructions and as reviewed by ENGINEER.
- C. Observations by OWNER or ENGINEER, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve CONTRACTOR of his responsibility to perform the work in accordance with these specifications.

1.6 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

- A. An inspection may be conducted during the eleventh month following completion of coating work. The CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. Defective work shall be repaired in accordance with these specifications and to the satisfaction of the OWNER. The OWNER may, by written notice to the CONTRACTOR, reschedule the inspection to another date within the one year correction period or may cancel the inspection altogether. The CONTRACTOR is not relieved of its responsibilities to correct defects whether or not the inspection is conducted.

PART 2 PRODUCTS

2.1 GENERAL

- A. CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.
- B. Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.
- C. In any coating system only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

- D. Colors and shades of colors of coatings shall be as indicated or selected by OWNER. Each coat shall be of a slightly different shade to facilitate observation of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the OWNER.
- E. Substitute or "Or-Equal" Products
1. Product Substitution: The specified coating systems are the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of ENGINEER. Requests for material substitutions shall be in accordance with requirements of the project specification.
 2. Product Requirements: The CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or equal" product that the material meets the indicated requirements and is equivalent or better in the following properties: Quality, Durability, Resistance to abrasion and physical damage, Life expectancy, Ability to recoat in the future, Solids content by volume, Dry film thickness per coat, Compatibility with other coatings, Suitability to chemical attack, Temperature limitations during application and in service, Type and quality of recommended undercoats or topcoats, Ease of repairing damaged areas, and stability of colors.
 3. Manufacturers of "or equal" products shall provide direct performance comparison with the materials specified, in addition to complying with all other requirements of these Specifications. "Or equal" products shall employ the same generic type materials and system components as the specified coating systems.
 4. CONTRACTOR shall bear any additional costs, if a proposed substitution requires changes or additional work.

2.2 COLORS

- A. Provide colors as selected by OWNER or ENGINEER unless otherwise specified herein.
- B. Colors shall be formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.
- C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply color matches.
- D. Equipment colors;
1. Equipment shall mean the machinery or vessel itself plus the structural supports and fasteners.
 2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as indicated below:
 - a. Dangerous parts of equipment and machinery: OSHA Orange
 - b. Fire protection equipment and apparatus: OSHA Red
 - c. Radiation hazards: OSHA Purple
 - d. Physical hazards in normal operating area: OSHA Yellow

3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.
- E. Piping color coding shall be in accordance with ANSI A13.1, Division of Drinking Water R-309-525, and International Plumbing Code.
1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe unless otherwise specified.
 2. Pipe supports: If pipe supports are not galvanized or stainless steel, supports shall be painted ANSI No. 70 light gray as specified in ANSI Z535.

2.3 COATING SYSTEMS

A. System No. 1 Steel – Interior Exposed

1. Materials

Type	Polyamidoamine Epoxy
VOC content, max, g/L	250
Volume Solids, min, %	67
Demonstrated Suitable for	Ferrous, galvanized, surfaces in industrial exposure, resistant to mild corrosion and chemical fumes, has good color and gloss retention
Certification	None

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils	Primer: Wasser MC-Moizinc100 Intermediate: Wasser MC-CR100 Finish: Wasser MC Ferrox A100	Primer: 3-5 DFT Inter.:5-7 DFT Finish: 2-4 DFT

3. Application
 - a. All exposed metal surfaces located inside of structures, excluding pre-painted electrical cabinets or equipment.
4. Special Requirements
 - a. The surface preparation and primer shall be shop applied to all surfaces prior to installation. Finish coats need only be applied to the surfaces exposed after completion of construction.
5. Color by Owner.

B. System No. 2 Steel – Doors and Frames

1. Materials

Type	Modified Polyamidoamine Epoxy with Aliphatic Acrylic Polyurethane (topcoat)
VOC content, max, g/L	250
Demonstrated Suitable for	Interior and Exterior Industrial, Architectural, and Commercial applications

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
SSPC-SP2/SP3 Hand and Power Tool Cleaning; feather rough edges; remove loose rust, dirt, and other contaminants with sandpaper	Primer: Tnemec Series 135 Chem-Build Finish: Tnemec Series 1075 Endura-Shield II	Primer: 3-5 DFT Finish: 3-5 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams HS Polyurethane 250	
	Primer: Devoe Devran 224 HS Finish: Devoe Devthane 379H	

3. Application

- a. Factory primed steel doors and frames
- b. Exterior and Interior steel in non-corrosive and non-immersion environments.
- c. Maintenance of existing marginally prepared rusty steel and tightly adhering old coatings.

C. System No. 3 Cast/Ductile Iron – Exterior and Interior Exposed

1. Materials

Type	Urethane, Aromatic, Aliphatic
VOC content, max, g/L	250
Demonstrated Suitable for	Ferrous, galvanized, nonferrous, cast/ductile iron surfaces in industrial exposure, highly resistant to abrasion, wet conditions, corrosive fumes, and exterior weathering

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils	Primer: Wasser MC-FerroClad Primer Intermediate: Wasser MC-CR100 Finish: Wasser MC Ferrox A100	Primer: 3-5 DFT Inter.:5-7 DFT Finish: 2-4 DFT

3. Application
 - a. Exposed cast/ductile iron surfaces located inside and outside of structures requiring painting and the following specific surfaces unless noted otherwise:
 - 1) All exposed cast/ductile iron pipe
4. Color by OWNER.

2.4 CONCRETE FINISHES

- A. Exterior Above Grade Concrete: Concrete surfaces exposed to view outside the building and including 6 inches below finished grade on the building or structure should be finished with a smooth form finish. Products for the smooth form finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.
- B. Interior Floor Slab Concrete: Interior floor slab concrete shall be finished with a trowel finish. Products for the trowel finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

PART 3 EXECUTION

3.1 GENERAL

- A. The intention of this specification is for all new surfaces, interior and exterior, wood, dry wall, masonry, concrete, and metal, whether atmospheric or submerged exposure, to be painted whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive a prime coat only unless modified herein.
- B. Surface preparation and coating application shall be in accordance with these specifications and the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflict occurs between the manufacturer's recommendations and these specifications, the more stringent of the two shall apply unless approved by ENGINEER.

3.2 REGULATORY REQUIREMENTS

- A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

- B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application, and dust prevention including but not limited to the following Acts, Regulations, Standards, and Guidelines:
 - 1. Clean Air Act
 - 2. National Ambient Air Quality Standard
 - 3. Resource Conservation and Recovery Act (RCRA)
 - 4. SSPC Guide 6
- C. Comply with applicable federal, state, and local regulations for confined space entry.
- D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

- A. Do not apply paint in extreme heat, temperatures below 40 degrees F, nor in dust, smoke-laden atmosphere, damp or humid weather. The Applicator shall adhere to the manufacturer's recommendations regarding environmental conditions. The Applicator shall monitor humidity, air temperature, and surface temperature with properly calibrated instruments.
- B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, nor whenever surface temperature is less than 5 degrees F above dew point of ambient air. Strictly adhere to manufacturer's recommendations.
- C. Surface preparation power tools and blast equipment shall contain dust collection devices that will prevent discharge of dust particles into the atmosphere around electrical or mechanical equipment unless otherwise permitted by ENGINEER.
- D. Where weather conditions or project requirement dictate, the Applicator shall provide and operate dehumidification equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified.

3.4 WORKMANSHIP

- A. Skilled craftsmen and experienced supervision shall be used on coating work.
- B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.
- C. Damage to other surfaces resulting from the work shall be cleaned, repaired, and refinished to original condition.

3.5 STORAGE, MIXING, AND THINNING OF MATERIALS

- A. Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.
- B. Coating materials shall be used within the manufacturer's recommended shelf life.
- C. Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.6 SURFACE PREPARATION

- A. All surfaces which receive paint or other coatings shall be prepared in accordance with the recommendations of the manufacturer of the material being used. The Applicator shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application.
- B. Perform sandblasting for piping and any other items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, and procedures shall meet requirements of the Society for Protective Coatings (formerly the Steel Structures Painting Council).

3.7 PROTECTION OF MATERIALS NOT TO BE PAINTED

- A. Surfaces that are not to receive coatings shall be protected during surface preparation, cleaning, and coating operations.
- B. Remove, mask or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
- C. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- D. Protect working parts or mechanical and electrical equipment and motors from damage.
- E. Care shall be exercised not to damage adjacent work during blasting operations. Spraying shall be conducted under carefully controlled conditions. CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blasting or coating operations.

3.8 SURFACE PREPARATION STANDARDS

- A. The following referenced surface preparation specifications of the Society for Protective Coatings shall form a part of this specification:

1. Solvent Cleaning (SSPC SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
2. Hand Tool Cleaning (SSPC SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
3. Power Tool Cleaning (SSPC SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
4. White Metal Blast Cleaning (SSPC SP5): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
5. Commercial Blast Cleaning (SSPC SP6): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.
6. Brush-Off Blast Cleaning (SSPC SP7): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.
7. Near-White Blast Cleaning (SSPC SP10): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.
8. Surface Preparation of Concrete (SSPC-SP13): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.9 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

- A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.
- B. Oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 - Solvent Cleaning prior to blast cleaning.
- C. Round or chamfer all sharp edges and grind smooth burrs and surface defects and weld splatter prior to blast cleaning.
- D. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.
- E. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.
- F. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

- G. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used.
- H. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning has been started.
- I. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.
- J. Exposed ductile iron pipe shall be given a shop coat of rust-inhibitive primer conforming to these specifications. Abrasive blasting of the asphaltic coating on ductile iron pipe will not be allowed.

3.10 SHOP COATING REQUIREMENTS

- A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish coated in the shop and then be touched up after installation.
- B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.
- C. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.
- D. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.
- E. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated, or less time if recommended by the coating manufacturer.

- F. CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.
- G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

3.11 APPLICATION

A. General

1. Schedule inspection with ENGINEER in advance for cleaned surfaces and all coats prior to each succeeding coat.
2. Apply coatings in accordance with the paint manufacturer's recommendations and these specifications, whichever is more stringent. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.
4. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.
5. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.
6. Non-buried steel piping shall be abrasive blast cleaned and primed before installation.
7. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.12 CURING OF COATINGS

- A. CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.
- B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.13 SHOP AND FIELD OBSERVATION AND TESTING

- A. CONTRACTOR shall give ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.
- B. Observation by ENGINEER, or the waiver of inspection of any particular portion of the work, shall not relieve CONTRACTOR of its responsibility to perform the work in accordance with these Specifications.
- C. CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film

thickness gauges shall be made available for ENGINEER's use while coating is being done, until final acceptance of such coatings. CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of ENGINEER.

- D. On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as Mikrotest Model FM, Elcometer Model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.
- E. Evaluation of blast cleaned surface preparation will be based upon comparison of the blasted surfaces with the standard samples available from NACE, using NACE standards TM-01-70 and TM-01-75.
- F. Visually inspect concrete, nonferrous metal, plastic, drywall, and wood surfaces to ensure proper and complete coverage has been attained.

3.14 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.
- B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.
- C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. Damages due to overspray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of CONTRACTOR.

3.15 MANUFACTURER' SERVICES

- A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

END OF SECTION

SECTION 22 13 29
SUBMERSIBLE DRY-PIT CHOPPER SEWER PUMP

PART 1 GENERAL SYSTEM DESCRIPTION

1.1 PERFORMANCE REQUIREMENTS

- A. Operating Conditions - Design: 425 GPM @ 55 FT TDH @ 56% efficiency
Maximum Motor HP: 20 HP

1.2 QUALITY ASSURANCE - REFERENCED STANDARDS

American Iron & Steel Institute (AISI)
American Society for Testing and Materials (ASTM)
Hydraulic Institute Standards for Centrifugal, Rotary, and Recip Pumps (HI)
National Fire Protection Agency (NFPA)
National Electric Code(NEC)
National Electrical Manufacturers Association(NEMA)
Anti-Friction Bearing Manufacturers Association(AFBMA)
International Standards Organization(ISO) - ISO9001

1.3 WARRANTY

- A. The pump manufacturer shall warrant the pump and motor to the Owner against defects in workmanship and materials for a period of five (5) years non-prorated under normal use and service. Pump manufacturer warranties shall be in published form, and shall apply to all similar units. A copy of the warranty shall be provided to the Owner at startup.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following are acceptable as Owner's standard equipment:
Barnes Sithe X-Pruf Chopper Pump – Series 4XESCD with no approved equal.

2.2 MATERIALS

- A. Submersible Sewage Pumps:

WET END

STRIKER PLATE: 440C Stainless Steel Heat Treated to 53-60 HRC Hole Pattern to
Accommodate 4" 125 # Flange

VOLUTE: Cast Iron ASTM A-48, Class 30

WEAR RING: C954 Lead-Free Bronze

IMPELLER: Design: White Iron 58 HRC
SLICING BLADE: 440C Stainless Steel Heat Treated to 53-60 HRC
“O” RINGS: Buna-N
HARDWARE: 300 Series Stainless Steel
COATING SYSTEM: Axalta Corlar® amidoamine epoxy

DRIVER

MOTOR: NEMA B Three Phase Torque Curve. Air-Filled, Squirrel Cage Induction,
Inverter Duty rated per NEMA MG1
Insulation: Class H
Efficiency: IE3
Voltage: 460
Service Factor: 1.15
SHAFT: 416 Stainless Steel
MOTOR HOUSING: Cast Iron ASTM A-48, Class 35B
SEAL BRACKET: Cast Iron ASTM A-48, Class 35B
BEARING BRACKET ASSEMBLY: Cast Iron ASTM A-48, Class 35B
HARDWARE & LIFTING BAIL: 300 Series Stainless Steel
SEAL: Design: Tandem Mechanical,
Material: Inboard: Carbon Rotating Face, Silicon Carbide Stationary Face
Outboard: Silicon Carbide Rotating Face, Silicon Carbide Stationary Face
Elastomer: Buna-N
Hardware: 300 Series Stainless Steel
UPPER BEARING: Design: Single Row, Ball, permanently Grease Lubricated
Load: Radial
LOWER BEARING: Design: Double Row, Ball, permanently Grease Lubricated
Load: Radial & Thrust
COATING SYSTEM: Resicoat® R4 Powder Coat Epoxy

2.3 ACCESSORIES

- A. POWER CABLE: Provide thirty (30) ft of power/control cable with each pump, suitable for submersible wastewater application, sized in accordance with NEC requirements. Provide cable terminal box on side of motor housing, with cable entry sealed to ensure that no entry of moisture is possible into the high-voltage motor/terminal area even if the cable is damaged or severed below water level. Cable seal shall include a compressed rubber grommet to seal the cable exterior and epoxy fill to seal the interior passages. Also, a monolithic dam formed by either soldering on bare stripped cable leads or by inserting cooper bushing over each individual cable lead shall be provided. A strain relief device, in direct contact with both the cable and the cast iron entry housing, shall be provided. The cable entry shall be rated by Factory Mutual (or UL) for submerged operating depths to 100 feet. Cable entries providing only simple grommet seals (external cable jacket) shall not be accepted. If a triple sealed cable entry is not utilized in the pump’s design, a separate moisture detector sensor shall be mounted in the terminal area to shut the pump down should moisture wick into the cable entry.

- B. TEMPERATURE PROTECTION: Furnish temperature monitoring devices in motor windings for use in conjunction with and supplemental to external motor overload protection. Arrange controls to shut down the pump should any of the sensors detect high temperature and automatically reset once motor temperature returns to normal. Set temperature monitors at levels recommended by pump manufacturer.
- C. SEAL LEAK DETECTION: Provide a humidity sensitive sensor in the motor's stator cavity which allows a control panel mounted relay to indicate leakage into the motor. Electronic probes which depend on sensing resistance value changes in seal oil will not be acceptable as seal leak indicators.
- D. The Pump Monitoring Relay shall be able to be mounted on the deadfront door of the control panel so that the deadfront door need not be opened to see the status of either the Seal Leakage condition or the Pump Over-Temperature status.
- E. The front of the Pump Monitoring Relay shall contain an LED indicator for power, an LED indicator for a Seal Leakage condition, and an LED indicator for an Over-Temperature condition.
- F. The front of the Pump Monitoring Relay shall also contain a selector switch to choose between "Auto Reset" and "Manual Reset". There shall be an Over-Temperature Reset push button to reset the Pump Monitor relay once the Over-Temperature condition has cleared.
- G. The front of the Pump Monitoring Relay shall also contain a potentiometer adjustment for setting where the unit will trip the alarm for the Seal Leakage condition. The mounting shall be 11-pin.
- H. The Pump Monitor Relay shall apply a low voltage DC signal to the Motor Thermal Sensor to check its status. When the Pump Monitor Relay detects that the Motor Thermal Sensor contacts are closed (normal condition), the Over-Temperature indicator shall remain off, and the Over-Temperature Relay shall be energized, closing the contacts between terminals 2 and 11.
- I. When the Motor Thermal Sensor contacts open (Over-Temperature condition), the Over-Temperature Indicator shall energize, and the Over-Temperature Alarm Relay shall de-energize, opening the contacts between terminals 2 and 11 and closing the contacts between terminals 2 and 1.
- J. When the Over-Temperature condition has cleared, the Pump Monitor Relay shall reset based on the selection of Alarm Reset Mode Select Switch (Auto or Manual). When in the Auto position, the Over-Temperature Alarm shall reset automatically. When in the Manual position, the Over-Temperature Reset Push-button must be pushed for approximately 1.5 seconds to clear the alarm.
- K. The Pump Monitor Relay shall detect moisture inside a pump motor by using a low voltage AC signal to measure the resistance between a single (or dual) Leakage

- Probe(s) and the grounded motor housing, or between two Leakage Probes. A Seal Leakage condition shall be considered present when the amount of moisture in the motor causes the resistance between terminal 6 and 5 to drop below the setting on the potentiometer. When this condition exists, the Pump Monitor Relay shall turn on the Leakage Indicator and energizes the Leakage Alarm Relay, closing the contacts between terminals 9 and 10.
- L. The leakage alarm trip point shall be set by the following procedure: Isolate the Leakage Probe(s) from terminals 5 and 6. Connect a resistor with the desired trip value across terminals 5 and 6. Slowly adjust the potentiometer to the point where the alarm turns on. Remove the resistor and reconnect to the Leakage Probe(s).

2.4 FABRICATION

- A. GENERAL: Provide pumps capable of handling raw unscreened wastewater. Pumps and motors shall be designed for continuous operation in a normally dry condition, but suitable for submerged operation. Provide combination vertical stand /suction elbow with covered, gasketed handhole cleanout cover. Provide pumps of "dry-shaft, back pull-out" design permitting removal of the complete rotating assembly without disconnection of suction or discharge connections.
- B. MAJOR COMPONENTS: Furnish major components (pump case, impeller, intermediate housing, and motor housing) of cast material as specified with smooth surfaces devoid of blow holes and other irregularities.
- C. CASING: Provide a volute casing with centerline discharge. It should be made of suitable thickness to allow for long pump life and to safely withstand the pressure at shut off pressure. The discharge nozzle shall be provided with integrally cast flange according to ASME/ANSI B 16.1 Class 125. Critical mating surfaces where watertight sealing is required shall be machined and fitted with o-rings. Fittings will be the result of controlled compression of rubber o-rings in two planes and o-ring contact of four sides without the requirement of a specific torque limit. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical o-rings, grease or other devices shall be used.
- D. IMPELLER AND WEAR RINGS: Provide non-clog type impeller, capable of passing at minimum a 3" spherical solid. Statically and dynamically balance the impeller. On all enclosed impellers, provide hard metal wear rings on case and impeller, of material and Brinell hardness specified, to ensure maximum pump/impeller life and continuing high efficiencies. Do not use elastomers as wear ring material as these are incompatible with the grit contaminating expected in the pumpage.
- E. SHAFT: Provide common pump/motor shaft of sufficient size to transmit full driver output with a maximum deflection of 0.002 inches measured at the lower mechanical seal. Machine the shaft of ASTM A276 Type 416 stainless steel.

- F. **SHAFT SEAL:** Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent single spring system acting in a common direction. Install the upper seal in an oil-filled chamber with drain and inspection plug (with positive anti-leak seal) for easy access from external to the pump. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced. Provide seals which are non-proprietary in design, with replacements available from a source other than the pump manufacturer or its distributors. Do not provide seals with the following characteristics: conventional double mechanical seals with single or multiple springs acting in opposed direction; cartridge-type mechanical seals; seals which incorporate a coolant circulating impeller; seals with face materials other than those specified; seals using the impeller hub as a mounting surface.
- G. **BEARINGS:** Furnish upper and lower bearings, single row (preferred) or double row as needed to provide a B10 life of, at minimum, 40,000 hours at anticipated axial and radial loadings. Provide sealed/shielded (permanently lubricated) bearings.
- H. **MOTOR:** Provide a submersible motor which is squirrel cage, induction in design, housed in a completely watertight and oil filled chamber, with a min 1.15 service factor suitable for dry mode operation as well as for fully submerged continuous operation without damage. Insulate the motor stator with, at minimum, Class F insulation rated for 311 Degrees F. Provide temperature protection and seal leak detection. Motors with any kind of liquid based cooling jackets, motors containing dielectric oils used for motor cooling and/or bearing lubrication or motors requiring the pump media and/or externally provided fresh water to be circulated through a cooling jacket shall not be acceptable.
- I. **SUCTION ELBOW WITH STAND:** To provide easy maintenance access to the impeller suction area, a suction elbow with stand for installation shall be supplied. The elbow and its incorporated stand shall be designed to bear safely all forces and moments which could ever occur during normal pump operation. The suction flange of the elbow should be according to ASME/ANSI B 16.1 class 125. The elbow shall include a covered clean-out port with appropriate diameter.
- J. **PROTECTIVE COATING:** Primer and Finish Paint-Shop apply to all exterior ferrous surfaces of the mixer and motor.
1. Solids by volume: 97%
 2. Type: Solvent-free ceramic coating, impregnated with aluminum oxides
 3. Total Dry Film Thickness: 400 microns (15 mils) minimum
 4. Minimum Adhesion: 15 Newtons per square millimeter (2,030 psi) per ISO 4624.
 5. Minimum Hardness: 110 on Buchholz Indentation scale
 6. Resistance: Level 1 (continuous duty) for sewage with pH of 6-11, Level 1 for saltwater, Level 3 (not recommended) for 10% hydrochloric acid.
 7. Surface Preparation-Prepare all surfaces to receive coating system.

- a) Method: Blasting per ISO 12944-4
- b) Standard Cleanliness Grade: 2.5
- c) Minimum Peak to Valley Height: 70 microns (2.75 mils)

PART 3 SOURCE QUALITY CONTROL

3.1 EQUIPMENT TESTS

- A. Tests shall be performed in accordance with the Test Code for Centrifugal Pumps per the Standards of the Hydraulic Institute. Tests shall be performed on the actual assembled pumps to be supplied or on duplicate previously constructed models. Tests shall cover a range from shut-off to at minimum 20% beyond specified design capacity. Conduct test per above specification on all supplied pumps, generating a curve showing actual flow, head, BHP and hydraulic efficiency.

3.2 VERIFICATION OF PERFORMANCE

- A. Field tests all pumps after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or over-heating. Any pump which fails to meet any of the contract specifications will be modified, repaired or replaced by the contractor at no additional cost to the owner.

END OF SECTION

SECTION 31 23 19 DEWATERING

PART 1 GENERAL

1.1 REQUIREMENTS

- A. The CONTRACTOR shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water from any source entering the excavations or other parts of the Work. Dewatering shall be accomplished by methods which will ensure a dry excavation and preserve the final lines and grades of the bottoms of excavations.
- B. Standing water in excavations will not be allowed. The CONTRACTOR shall maintain a dry working area for excavations.
- C. CONTRACTOR shall follow all county and state requirements.
- D. Design of dewatering systems and methods should be the sole responsibility of the CONTRACTOR. The CONTRACTOR's dewatering plans must take into consideration the subsurface conditions at the site. The CONTRACTOR shall independently evaluate dewatering systems and make his own selection of appropriate dewatering techniques that meet the project requirements. The ground support and dewatering systems are interdependent and, as such, the ground support and dewatering systems shall be submitted by the CONTRACTOR at the same time for review.
- E. Whatever dewatering systems are used, the ground support and dewatering system should together meet all of the following minimum requirements:
 - 1. Provide stable excavation walls and bottom.
 - 2. Provide dry base of excavation.
 - 3. Filter native soil and prevent loss of ground through piping.
 - 4. Prevent hydrostatic uplift pressure during construction.
 - 5. Preserve the undisturbed bearing capacity of the soils below the base of the excavation.
 - 6. Where shoring is not designed to resist hydrostatic pressures, draw down the groundwater level below and beyond the excavation sidewalls.
- F. Contractor shall obtain all necessary permits for disposal of water removed from the excavation.

1.2 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- B. Before dewatering is commenced, Contractor shall provide information to Engineer outlining the method, installation and details of the proposed dewatering system. CONTRACTOR shall provide ENGINEER with plans setting forth details of the proposed dewatering systems. The dewatering system plans shall be of sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water, and to indicate the overall completeness and effectiveness of the proposed system.
- C. CONTRACTOR shall certify to OWNER that the design and implementation of the proposed dewatering system is sufficient to complete the Work.
- D. Submit a plan to monitoring settlement of adjacent structures.

1.3 QUALITY CONTROL

- A. Contractor shall be responsible to control the rate and effect of dewatering to avoid all settlement and subsidence.
- B. Where critical structures exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. Contractor is responsible for protecting adjacent structures from settlement. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Where pumping equipment is used, a standby unit of equal size shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DESIGN AND IMPLEMENTATION

- A. CONTRACTOR shall be responsible for complete design and implementation of the dewatering system.
- B. CONTRACTOR shall be responsible for the design and implementation of any modifications that may be required to the initial design of the dewatering system (at no additional cost to OWNER) to provide a dewatering system that operates adequately to complete the Work.
- C. CONTRACTOR shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction.

- D. CONTRACTOR shall dispose of water so as to not cause damage to public or private property, or to cause a nuisance or menace to the public or violate the law.
- E. CONTRACTOR shall be responsible to obtain groundwater discharge permits, if required.
- F. CONTRACTOR shall install and operate the dewatering system so as to not cause damage or endanger adjacent structures or property.
- G. The control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils," does not occur. Dewatering systems shall be designed and operated so as to prevent removal and migration of the natural soils.
- H. CONTRACTOR shall have sufficient stand-by equipment at the project site at all times to continuously maintain the dewatering program until Work necessitating dewatering is complete.
- I. CONTRACTOR shall have on hand equipment and machinery in good working condition for emergencies and shall have personnel available for operation of such equipment and machinery.
- J. CONTRACTOR shall control surface water to prevent entry into excavations.

- END OF SECTION -

SECTION 31 23 23
EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section covers excavating, backfilling, and compacting of disturbed areas for structures as directed by ENGINEER.

1.2 GEOTECHNICAL REPORT

- A. Refer to the geotechnical report by IGES dated May 31, 2018 for additional requirements.

1.3 REFERENCES

- A. The latest edition of the following publications form a part of this specifications to the extent referred. The publication are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. T 88 Particle Size Analysis of Soils
2. T 180 Moisture-Density Relations of Soils Using a 10-lb. (4.54 kg) Rammer and an 18-in (457 mm) Drop
3. T 191 Density of Soil In-Place by the Sand-Cone Method
4. T 205 Density of Soil In-Place by the Rubber-Balloon Method
5. T 238 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
6. T 239 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. D 422 Particle-Size Analysis of Soils
2. D 698 Test Method of Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in. (305-mm) Drop
3. D 1556 Density of Soil in Place by the Sand-Cone method
4. D 1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
5. D 2487 Classification of Soils for Engineering Purposes
6. D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow eDepth)

- D. The latest Edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction.
- E. The latest Edition of the American Public Works Association (APWA) and Associated General Contractors of America Standard Plans and Standard Specifications.

1.4 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00 Submittal Procedures:
 - 1. Submit gradations and proctors for structural fill materials and backfill materials.

PART 2 PRODUCTS

2.1 STRUCTURAL FILL

- A. Footings for the structure should be established *entirely* on undisturbed native non-collapsible soils (no pinholes), such as the native gravel soils and bedrock material, or on a minimum of 24 inches of structural fill if collapsible soils are encountered. The structural fill should have a minimum of 25% fines (such as the native soil) to provide a low permeability barrier against moisture infiltration.

PART 3 EXECUTION

3.1 EXCAVATION

- A. Excavation shall be performed to the lines and grades indicated. Excavated material not required or not satisfactory for backfill shall be removed from the site.
- B. Excavations shall be braced and supported as needed to prevent the ground adjacent to the excavation from sliding or settling. Slides shall be promptly removed and corrected by the Contractor.

3.2 PREPARATION

- A. See Geotechnical report from IGES dated May 31, 2018 for requirements.

3.3 FOUNDATIONS

- A. It is anticipated that the footings for the structure will be placed on a minimum of 8 inches of gravel extending to the bedrock and/or native, undisturbed soil (if applicable).

3.4 BACKFILL

- A. Backfill material shall not be placed against concrete structures that have not been properly cured. No backfill material shall be placed until concrete until the compressible strength is 85 percent of the specified strength.
- B. Structural fill should be placed in maximum 12-inch loose lifts and compacted by equipment capable of compacting a 12-inch lift on a horizontal plane, unless otherwise approved by the Geotechnical Engineer. Structural fill beneath the structure should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557. The moisture content should be slightly above optimum at the time of compaction. Also, prior to placing fill, the excavations should be observed by the geotechnical representative to confirm that unsuitable materials have been removed.
- A. Backfill material not located beneath the structure shall be placed and compacted to at least 90 percent of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D-1557.
- B. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and re-compacted to the minimum required compaction prior to placing any additional fill material.
- C. The CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If it is determined that the CONTRACTOR is failing to meet the minimum requirements, the CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to the OWNER.
- D. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of this contract.
- E. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by CONTRACTOR.

3.5 FINISHED GRADE

- A. The finished subgrade and grade of the fill shall not vary more than 0.05 feet from the established grades and cross-sections shown on the Drawings.

3.6 COMPACTION TESTS

- A. Compaction Quality Control Testing shall be the provided and paid for in accordance with Section 01 45 00.

- B. It shall be the responsibility of the CONTRACTOR to accomplish the specified compaction for backfill, structural fill, Untreated Base Course and other earthwork. It shall be the responsibility of the CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

- a) Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01 45 00.
- b) The CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
 - (i) One (1) test per 1.5 feet of backfill thickness placed per structure.
- c) Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
- d) After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.
- e) Quality Control tests may be made by the OWNER to verify that compaction is meeting the requirements previously specified at no cost to the CONTRACTOR. If the OWNER requires retesting of backfill, CONTRACTOR shall remove the overburden above the level at which the OWNER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost to OWNER.
- f) If compaction fails to meet the specified requirements, the CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to the OWNER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid in accordance with Section 01 45 00. The confirmation tests shall be performed in a manner acceptable to the OWNER. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

2. Field Density Tests

- a) Tests shall be performed in sufficient numbers to meet the requirements of Section 01 45 00 and to ensure that the specified density is being obtained.

- C. Field density tests shall be made in accordance with ASTM D-1557 and ASTM D-2922.

- END OF SECTION -

SECTION 31 41 00 SHORING

PART 1 - GENERAL

1.01 DESCRIPTION

Properly support all excavations to protect life, property and the work.

1.02 STANDARDS

Occupational Safety and Health Administration (OSHA) regulations, Federal Register Vol. 37, No. 243, Sub-part P., Sec. 1926.652.

PART 2 - MATERIALS

Contractor to be responsible for shoring or bracing system used. Materials used shall have adequate strength to support excavations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide and install, wherever required for protection of life and/or property, temporary or permanent sheeting, shoring and bracing as required to support the sides of a trench or a temporary nonconforming vertical slope to prevent any dangerous movement, subsidence inflicting damage, or delay. Comply with all safety requirements.
- B. Provide and install transverse bulkheads, solid sheeted or interlocking sheeting, driven deep enough below grade to prevent the inflow of material from outside of trench if required to preserve a suitable grading for the pipe of structural excavation.
- C. Remove all timber and sheeting from excavations or trenching before backfilling or cut sheeting off 2-feet below final grade if allowed by Engineer.
- D. Shoring and or bracing shall be used where excavations may damage existing improvements. Where the depth of the excavation or the conditions encountered during construction may cause harm or damage to existing facilities such as fences, buildings, landscaping, etc., the Contractor shall take whatever action is necessary to prevent damage to the existing improvements. Where existing improvements are damaged or affected as a result of the Contractor's work, the Contractor shall replace or repair such damage at no additional cost to the Owner.

END OF SECTION

SECTION 32 11 23
ROAD BASE - UNTREATED BASE COURSE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This work consists of the placement of Sub-Base and Untreated Base Course material at designated road ways and all driving surfaces as indicated on the Drawings.

1.2 REFERENCES

- A. The latest edition of the following publication forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS (AASHTO)**

- AASHTO T 88- Particle Size Analysis of Soils
- AASHTO T 180- Moisture-Density Relations of Soils Using a 10-lb. (4.54 kg)
Rammer and an 18-in (457 mm) Drop
- AASHTO T 191- Density of Soil In-Place by the Sand-Cone Method
- AASHTO T 205- Density of Soil In-Place by the Rubber-Balloon Method
- AASHTO T 238- Density of Soil and Soil-Aggregate in Place by Nuclear Methods
(Shallow Depth)
- AASHTO T 239- Moisture Content of Soil and Soil-Aggregate in Place by Nuclear
Methods (Shallow Depth)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D 422- Particle-Size Analysis of Soils
- ASTM D 698- Test Method of Moisture-Density Relations of Soils and
Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in.
(305-mm) Drop
- ASTM D 1556- Density of Soil in Place by the Sand-Cone method
- ASTM D 1557- Moisture-Density Relations of Soils and Soil-Aggregate Mixtures
Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
- ASTM D 2487- Classification of Soils for Engineering Purposes
- ASTM D 2922- Density of Soil and Soil-Aggregate in Place by Nuclear Methods
(Shallow Depth)
- ASTM D 3017- Water Content of Soil and Rock in Place by Nuclear Methods
(Shallow Depth)

- B. The latest edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction (UDOT).

1.3 SUBMITTALS

- A. Untreated Base Course (APWA Grade 1 or Grade 1 ½).

PART 2 PRODUCTS

2.1 MATERIALS

- A. Untreated Base Course Materials shall meet the APWA Specifications for Grade 1 or Grade 1 ½ as shown in Table 1.

TABLE 1

SIEVE SIZE	GRADE 1 GRADATION (PERCENT PASSING)	GRADE 1 ½ GRADATION (PERCENT PASSING)
1 1/2 inch	-	100
1 inch	100	-
3/4 inch	-	70 - 85
1/2 inch	79 - 91	-
3/8 inch	-	55 - 75
No. 4	49 - 61	40 - 65
No. 16	27 - 35	25 - 40
No. 200	7 - 11	7 - 11

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

- A. Prior to placement of untreated base course materials, the foundation area to receive untreated base course materials shall be scarified to a minimum depth of 8-inches and recompacted to 95% minimum laboratory density as determined by ASTM D-1557.

3.2 UNTREATED BASE COURSE MATERIAL PLACEMENT

- A. No Untreated Base Course material shall be placed on sub-grade materials until the sub-grade has been checked and accepted by ENGINEER.
- B. Road base material placed on driving surfaces shall be compacted to a minimum density of 96% in accordance with ASTM D-1557 to provide a uniform graded smooth surface.

- C. Untreated Base Course material shall be placed to a minimum thickness eight (8) inches or as shown on the drawings.

3.3 FIELD QUALITY CONTROL

- A. CONTRACTOR shall be responsible for directing proper placement of all road base materials. CONTRACTOR shall be responsible for the stability of the road base materials during placement and shall replace any portions which have become displaced due to careless or negligent work on the part of CONTRACTOR, or to damage resulting from natural causes, such as storms.
- B. Whenever the work areas to receive Sub-Base and/or Untreated Base Course material are covered with snow, the snow must be removed prior to placing the road base and/or Untreated Base Course, and deposited outside the immediate construction areas at CONTRACTOR's expense.

- END OF SECTION -

SECTION 32 12 16
HOT-MIX ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

- A. This section addresses the requirements for installing hot-mix asphalt concrete, as outlined in Section 33 05 25 – Pavement Restoration of the APWA Specifications, and as modified herein.

1.2 RELATED SECTIONS

- A. Related work specified in other sections includes but is not limited to:

Section 32 11 23 – Road Base – Untreated Base Course

Section 32 12 13.13 – Tack Coat (APWA)

Section 32 12 16.13 – Plant-Mix – Asphalt Paving (APWA)

Section 33 05 25 – Pavement Restoration (APWA)

1.3 REFERENCES

- A. The American Public Works Association General Conditions and Standard Specifications for Construction, latest edition.
- B. The following are also references applicable to this section.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1559: Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

ASTM D 2041: Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.

ASTM D 2950: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method.

ASTM D 3665: Standard Practice for Random Sampling of Construction Materials.

1.4 SUBMITTALS

- A. Laboratory mix design for proposed hot-mix asphalt concrete paving.
- B. Means and methods for removal, reprocessing, and placement of existing asphalt surfaces as base course material.
- C. Laboratory mix design for proposed tack coat application.

- D. Quality assurance tests for asphalt and aggregate material sources.
- E. Copies of batch delivery tickets shall be submitted during progress of the work, and shall show the following information:
 - 1. Name of production facility
 - 2. Serial number of ticket
 - 3. Date and truck number
 - 4. Name of CONTRACTOR
 - 5. Job name and location
 - 6. Weight of asphalt concrete
 - 7. Loading temperature
 - 8. Signature or initial of plant representative
 - 9. Type and grade of asphalt cement
 - 10. Type and grade of aggregate
 - 11. Applicable mix design method
 - 12. Separate weights of aggregate and asphalt
- F. Submit type and number of rollers required for compacting asphalt concrete

1.5 SITE CONDITIONS

- A. Pave only when air and roadbed temperatures in the shade are greater than 40 deg. F. The temperature restrictions may be waived only upon written authorization from ENGINEER.
- B. Do not pave during rain or unsuitable weather or when surface is wet.

1.6 ACCEPTANCE

- A. Acceptance of hot-mix asphalt concrete paving is based upon minimum density, minimum thickness, smoothness, and surface appearance. Smoothness and surface appearance shall be as defined by Section 32 12 16.13 of the APWA Specifications.

PART 2 PRODUCTS

2.1 BITUMINOUS MATERIAL

- A. The bituminous material shall be **PG 58-28** for the 1/2" mix design.
- B. Sampling and testing shall be the responsibility of CONTRACTOR, and shall be performed as required in Section 01 45 00 - Quality Control and Materials Testing.

2.2 TACK COAT

- A. Tack coat material shall conform to all requirements of Section 32 12 13.13 - Tack Coat (APWA).

PART 3 EXECUTION

3.1 PREPARATION

- A. Preparation shall conform to all requirements of Section 32 12 16 of the APWA specifications.
- B. CONTRACTOR shall map and mark all existing surface utilities within the line of work, and shall lower fixtures if pavement machine is not capable of passing over structure.
- C. All asphalt and concrete surfaces within the line of work are to be removed and disposed of properly by the CONTRACTOR. The CONTRACTOR may, upon written authorization of the OWNER, use processed asphalt materials as base course material. Excess materials shall be removed and disposed by the CONTRACTOR.
- D. Existing asphalt pavements and drive approach extensions to be removed shall be cut by a wheel cutter, clay spade, or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement and/or concrete that is not to be removed. The cutting device operation shall be subject to the approval of the ENGINEER.
- E. Any existing base, surfacing, or pavement shall be thoroughly cleaned immediately prior to receiving the plant-mixed surfacing. Where existing pavement is being widened or extended, it shall be cut to a straight vertical face prior to the paving operations and treated with asphalt paint binder.

3.2 BASE COURSE

- A. Base course material shall be placed in accordance with Section 32 11 23 of these specifications.
- B. Base course surfaces shall be maintained in an acceptable condition for both moisture and density, as defined by Section 32 11 23 - Road Base, until the overlying hot-mix asphalt cement materials have been placed, at no additional expense to the OWNER.

3.3 PLACEMENT OF TACK COAT

- A. Apply tack coat to all existing asphalt concrete surfaces preparatory to placing asphalt concrete pavement in accordance with Section 32 12 13.13 – Tack Coat of the APWA specifications.

3.4 PLACEMENT OF HOT-MIX ASPHALT CONCRETE

- A. For all excavations within twenty-four (24) inches of any structure, concrete, or edge of existing pavement surface; CONTRACTOR shall remove and replace existing pavement surface to the concrete, structure, or edge of existing pavement surface.
- B. Where a longitudinal trench is partly in pavement, the pavement shall be replaced to the original pavement edge, on a straight line, parallel to the center line of the roadway.
- C. Where no part of a longitudinal trench is in the pavement, surfacing replacement will only be required where existing surfacing materials have been removed.
- D. Spreading shall be as nearly continuous as possible.
- E. Placement shall also allow for line, grade, elevations, and thickness specified herein and as shown on the drawings.
- F. When asphalt concrete is laid against vertical surfaces such as gutters, the face of the vertical surface shall be roughened for proper bonding, cleaned, and then painted with a light coating of asphalt cement or emulsified asphalt.
- G. At terminations of new surface course, the asphalt concrete shall be feathered into the existing surface over such a distance as may be required to produce a smooth riding transition. Base course and single course construction shall be joined by vertical butt joints finished and rolled to a smooth surface.
- H. Asphaltic concrete shall not be placed when frozen materials are present in the base or sub-base.
- I. Asphaltic concrete shall not be placed during adverse conditions, i.e., rain or when a roadway surface is wet.
- J. Asphaltic concrete shall be placed between April 15 and October 15. Asphalt concrete shall not be placed after October 15 and before April 15 of the following year unless roadway surface temperatures are 50-deg F and rising in the shade. Approval to place the asphalt concrete after October 15 and before April 15 of the following year requires written approval from the OWNER.
- K. Roadways not completed prior to October 15, and not meeting the requirements of this section, shall be repaired by placing a temporary 2-inch thick asphalt (or other ENGINEER approved surface) course over all exposed, earthen surfaces. These temporary surfaces shall be completely removed and repaired in accordance with these specifications at no additional expense to the OWNER.
- L. Asphalt rolling shall be in accordance with Section 32 12 16 of the APWA specifications. The CONTRACTOR shall establish and document a rolling pattern

for obtaining densities. The test strip shall be no shorter than 300 feet. Establishment of rolling patterns are for the purpose of establishing minimum rolling patterns, and shall not release the CONTRACTOR of meeting all requirements of these specifications and drawings.

- M. The target density for asphalt placement shall be 94 percent of laboratory density plus or minus two (2) percent. If an individual test result falls below 92 percent of maximum density, the material represented by that test will be considered defective, and shall be removed and replaced by the CONTRACTOR at no additional cost to the OWNER.
- N. The minimum acceptable thickness of asphalt for completed roadways shall be 3 inches, as verified by core samples. Areas found to contain less than the minimum thickness shall be removed and replaced at no additional expense to the OWNER.
- O. The completed finish shall be as specified in Section 32 12 16 of the APWA specifications.
- P. CONTRACTOR shall adjust the height of all street fixtures to match final grade. If required, concrete collars shall be placed around all surface street fixtures (i.e. manholes, valve boxes, monuments, etc.).
- Q. CONTRACTOR shall complete all concrete collars within 2 weeks of completion of paving each roadway section.
- R. CONTRACTOR shall restripe streets, as required, in accordance with Section 32 17 23 - Pavement Markings of the APWA specifications.

3.5 SITE SAFETY AND TRAFFIC CONTROL

- A. Site safety and traffic control shall be the responsibility of the CONTRACTOR.
- B. The CONTRACTOR shall verify full compliance with all applicable local, county, state and/or federal regulations, and shall comply with Traffic Control in Section 01 55 26.

- END OF SECTION -

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY

- A. This section covers the furnishing of labor, materials and appurtenances necessary for installation of the PVC coated chain link fence system defined herein. The manufacturer shall provide a total fence system including all components, panels, posts, gates, and hardware required.

1.2 REFERENCES

- A. AMERICAN PUBLIC WORKS ASSOCIATION 2017 EDITION (APWA)

1. Plan 832 Chain Link Fence
2. Section 32 31 13 Chain Link Fence and Gates

- B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
2. ASTM F 552 Standard Terminology Relating to Chain Link Fencing
3. ASTM F 567 Standard Practice for Installation of Chain Link Fence
4. ASTM F 626 Standard Specification for Fence Fittings
5. ASTM F 668 Standard Specification for Polyvinyl (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric
6. ASTM F 900 Standard Specification for Industrial and Commercial Swing Gates
7. ASTM F 934 Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials
8. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
9. ASTM F1664 Standard Specification for Poly (Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence
10. ASTM F1665 Standard Specification for Poly (Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence

1.3 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- B. Shop drawings: Site plan showing layout of fence location with dimensions, location of gates and opening size, cleared area, elevation of fence, gates, footings and details of attachments.

- C. Certifications: Manufacturer's material certifications in compliance with the current ASTM specifications.
- D. Material samples: When required, provide representative samples of chain link fabric, framework and fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.5 QUALITY ASSURANCE

- A. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 and have at least 5 years' experience.
- B. Tolerances: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.6 WARRANTY

- A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 5 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

PART 2 PRODUCTS

2.1 GENERAL

- A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.
- B. Fence fabric height shall be 6 feet unless otherwise indicated.
- C. Fencing materials shall be galvanized and PVC coated after fabrication.
- D. The color of the fencing fabric, poles, and fittings shall be black.

2.2 STEEL FABRIC

- A. Fence fabric shall be 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.
- B. Fabric shall be hot-dip galvanized and PVC coated according to ASTM F668, Class 2a or Class 2b. The weight of the zinc shall meet the requirements of STM F 668, Table 4.

2.3 FRAMING AND ACCESSORIES

- A. Round steel pipe and rail: Schedule 40 standard weight pipe, in accordance with ASTM F1083, 1.8 oz/ ft² hot dip galvanized zinc exterior and 1.8 oz/ft² hot dip galvanized zinc interior coating. Intermediate Strength Grade: Minimum yield strength 50,000 psi.
 - 1. Line post shall be 2-3/8" outside diameter, 1.8 oz/ft² zinc coating.
 - 2. End, Corner, Pull post 2-7/8" outside diameter, 1.8 oz/ft² zinc coating.
 - 3. Top, brace, bottom and intermediate rails, 1.660" outside diameter, 1.8 oz/ft² zinc coating.
- B. Polymer Coated Pipe: Polymer coated pipe shall have a PVC coating fused and adhered to the exterior zinc coating of the galvanized pipe in accordance with ASTM F1043. The minimum thickness of the PVC coating shall be 10-mils (0.254 mm). The color shall match fabric black per ASTM F934.
- C. Tension Wire: Tension wire shall be located at the bottom of the fabric and shall consist of 7 gauge wire complying with ASTM F 1664. Wire gauge specified is the core wire gauge. The color shall match the coating of the chain link fabric and shall be Class 2a or Class 2b. Tension wire shall be interlaced with the fabric or attached to the fabric with wire ties at a spacing of no more than 18 inches apart.
- D. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.), minimum width of 3/4 inch and minimum zinc coating of 1.20 oz/ft². Secure bands with 5/16 inch galvanized steel carriage bolts.
- E. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft².
- F. Truss Rod Assembly: In compliance with ASTM F626, 3/8 inch diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft², assembly capable of withstanding a tension of 2,000 lbs.
- G. Tension Bars: Tension bars shall be in accordance with ASTM F626 and shall be galvanized steel one-piece length 2 inch less than the fabric height. Minimum zinc coating 1.2 oz. /ft². Bars for 2 inch mesh shall have a minimum cross section of 3/16 inch by 3/4 inch.
- H. Polymer Coated Color Fittings: In compliance with ASTM F626, PVC coating minimum thickness 0.006 in. (0.152 mm) fused and adhered to the zinc coated fittings. Match color to fence system.
- I. Tie Wire and Hog Rings: Galvanized minimum zinc coating 1.20 oz/ft², 9 gauge (0.148") steel wire in compliance with ASTM F626. Tie wire and hog rings shall be polymer coated and match the color of the fence system.

2.4 SWING GATES

- A. **Swing Gates:** Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900 inch outside diameter, ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 ft. apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A 780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. The gate post diameter from table 2.5.B. Gate frames and gate posts shall be PVC coated and match the color of the fence system.
- B. **Gateposts:** Schedule 40 pipe in compliance with ASTM F1083.

Gate fabric height up to and including 6 ft.		
Gate leaf width	Post Outside Diameter	Weight
up to 4 ft.	2.375 in.	3.65 lb/ft
over 4 ft. to 10 ft.	2.875 in.	5.79 lb/ft
over 10 ft. to 18 ft.	4.000 in.	9.11 lb/ft
Gate fabric height over 6 ft. to 12 ft.		
Gate leaf width		
up to 6 ft.	2.875 in.	5.79 lb/ft
over 6 ft. to 12 ft.	4.000 in.	9.11 lb/ft
over 12 ft. to 18 ft.	6.625 in.	18.97 lb/ft
over 18 ft. to 24 ft.	8.625 in.	28.58 lb/ft

2.5 CONCRETE

- A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi.

PART 3 EXECUTION

3.1 FRAMEWORK INSTALLATION

- A. **Posts:** Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 24 inch plus an additional 3-inch depth for each 1 ft. increase in the fence height over 4 ft. or as indicated on the contract drawings whichever is greater. The minimum footing diameter shall be four times the largest cross section of the post up to a 4.00" dimension and three times the largest cross section of post greater than a 4.00" dimension or as indicated on the contract drawings, whichever is greater. Top of concrete footing to be at grade and crowned to shed water away from the post. Line posts installed at intervals not exceeding 10 ft. on center.
- B. **Top rail:** When specified, install 21 ft. lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 inches long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail

shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end. Fences 12 feet high or higher require mid rail.

- C. Terminal posts: End, corner, pull and gate posts shall be braced and trussed for fence 6 ft. and higher and for fences 5 ft. in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.
- D. Tension wire: Shall be installed 4 inches up from the bottom of the fabric. Fences without top rail shall have a tension wire installed 4 inches down from the top of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire. Install the top tension wire through the barb arm loop for fences having barbed wire and no top rail.

3.2 CHAIN LINK FABRIC INSTALLATION

- A. Chain Link Fabric: Install fabric to outside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 inch carriage bolts spaced no greater than 12 inches on center. Chain link fabric shall be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to horizontal rail spaced no greater than 18 inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches on center.
 - 1. Tie wire shall be wrapped 360 degrees around the post or rail and the two ends twisted together three full turns. Excess wire shall be cut off and bent over to prevent injury. The installed fabric shall have a ground clearance on no more than 2 inches.

3.3 BARBED WIRE INSTALLATION (IF SPECIFIED)

- A. Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band.

3.4 GATE INSTALLATION

- A. Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be inward. Gates shall be plumb in the closed position having a bottom clearance of 3 inch, grade permitting. Hinge and latch offset opening space shall be no greater than 3 inches in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum 6 inch diameter 24 inch deep. Gate leaf holdbacks shall be installed for all double gates.

END OF SECTION 32 31 13

SECTION 33 05 20 TRENCHING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Excavating trenches for utilities and utility structures.
 - 2. Backfill and compaction for utility trenches.

1.2 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M145 - Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
 - 2. AASHTO T99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 - 3. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. Occupational Safety and Health Administration (OSHA).

1.3 DEFINITIONS

- A. Backfill: Material placed after utilities and bedding.
- B. Coarse Grained Soil: Soils with more than 50 percent retained on No. 200 sieve.
- C. Fine Grained Soil: Soils with 50 percent or more passing No. 200 sieve.
- D. Soil Classification: ASTM D2487 and AASHTO M145.
- E. Trench Excavation Classification: Will be based on soil type and equipment required.
 - 1. Trench Excavation: Excavation of unclassified soils. Use minimum of 330 trackhoe with ripper shank or equal equipment. Contractor may elect to use larger equipment, but electing to use larger equipment will not change classification of excavation.
 - 2. Rock Trench Excavation: Excavation of solid rock which requires using excavator with rock hammer or use of explosives, and cannot be removed with minimum equipment required for unclassified soils noted above.
- F. Utility: Any buried pipe, duct, conduit, cable and appurtenance.

1.4 SUBMITTALS

- A. Test Results: Submit proctor and density quality control test results within 24 hours after testing is completed.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Gravity Line Bedding: Gravity sewer lines shall be bedded using clean, free draining, well graded, crushed gravel with a maximum aggregate size of $\frac{3}{4}$ inch. The material shall meet the following gradation requirements:

<u>Sieve Size (Square Opening)</u>	<u>Percent By Weight Passing Screen</u>
1-inch	100
$\frac{3}{4}$ inch	90 - 100
$\frac{1}{2}$ -inch	20 - 55
No. 4	0 - 10
No. 8	0 - 5

- B. PVC Force Main Bedding: Pressurized PVC lines shall be bedded using $\frac{3}{4}$ inch minus crushed rock of which 100% will pass the U.S. Standard $\frac{3}{4}$ -inch opening and not more than 3% will pass the U.S. No. 200 (wet sieve), graded granular sand or rejected road base.
- C. Backfill: Excavated material free from rubbish, debris, organic material, frozen material, or other objectionable material.
1. Rocks originating from trench and not exceeding 6 inches.
 2. Broken Portland cement concrete and asphalt concrete pavement originating from trench and not exceeding 6 inches.
 3. If excavated material is not suitable for backfill, import granular material.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and existing utilities being crossed prior to Work.
- B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

3.2 PREPARATION

- A. Call Blue Stakes not less than two working days before performing Work. Request underground utilities to be located and marked within and surrounding construction areas.

- B. Identify required location and elevation of new utility lines and buried structures.
- C. Notify Engineer immediately after utility conflicts are identified.
- D. Erect and maintain temporary barriers, safety devices and similar measures for protection of public and existing improvements to remain.
- E. Install appropriate erosion and sediment control measures prior to starting trenching.
- F. Clear vegetation, debris, and rubbish from utility alignment. Dispose of material off site.
- G. When trench is in sodded areas, carefully remove sod and stockpile for placement after backfill is placed.
- H. When trench is in cultivated areas, remove 12 inches of topsoil and stockpile for placement as final layer of backfill.

3.3 EXCAVATION

- A. Excavate soil required for installation of utility lines and appurtenances.
- B. Cut trenches sufficiently wide to enable installation of pipe and appurtenances, and allow inspection. Cut slope of trench walls to meet Utah State Industrial Commission and OSHA requirements, and soil conditions. Provide shoring where needed. Take necessary precautions to protect employees in or around excavations.
- C. Remove water from trench. Maintain trenches free from water. Dewatering of trench will be considered incidental to trenching and shall be included in bid price.
- D. Hand trim excavation for bell and spigot pipe joints and to required elevation for buried structures. Remove materials that interfere with Work.
- E. Remove lumped soil, boulders, and rock.
- F. Correct areas over excavated and re-compact.
- G. Stockpile excavated material alongside of trench or in other areas to minimize damage to improvements.
- H. No more than 500 linear feet of open trench permitted. At end of each work day, bring backfill operation concurrent with excavation operation.

- I. For pipe, minimum width of trench shall not be less than outside diameter of pipe plus 12 inches on each side of pipe.
- J. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and utilities.
- K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with suitable material, and compact to density equal to or greater than requirements for subsequent backfill material.

3.4 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on Drawings.
- B. Use laser-beam instrument with qualified operator to establish lines and grades.
- C. Engineer may make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

3.5 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil. Meet OSHA requirements.
- B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- C. Design sheeting and shoring to be removed at completion of trenching work.
- D. Repair damage caused by failure of sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- E. Repair damage to new and existing work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.6 BACKFILL

- A. After utilities, appurtenances, and bedding have been installed; backfill trenches. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- B. Employ placement method that does not disturb or damage utilities and other improvements.
- C. Backfill in layers not exceeding 12 inches non-compacted depth. Reduce layer thickness if tests show unsatisfactory density. Use hand-operated compaction

equipment in areas inaccessible to self-propelled compaction equipment. When using hand-operated compaction equipment, backfill in layers not exceeding 6 inches no-compacted depth.

- D. Mix rocks with finer material to minimize voids. Do not place rocks exceeding 2 inches within 12 inches of pavement subgrade and within 2 feet of structures.
- E. When trench is in cultivated areas, place stockpiled topsoil in final layer of backfill. Remove rocks exceeding 1.5 inches from topsoil.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density.
- G. Compact backfill to density indicated in Compaction Schedule at end of this Section.
- H. Grade surplus material to blend in with existing contours or remove surplus materials from site if necessary. Do not leave rocks originating from trench and exceeding 2 inches on finish grade.
- I. Slope surface grade away from buried structures.
- J. Restore damaged surface improvements including, but not limited to: fences, ditches, culverts, signs, delineators, curbs, sidewalks, structures, landscaping, and other miscellaneous items. Restore improvements to equal or better condition as existed prior to construction.

3.7 TOLERANCES

- A. Top Surface of General Backfill: Plus or minus 0.1 foot from required elevations.
- B. Top Surface of Backfill under Paved Areas: Plus or minus 0.04 foot from required subgrade elevation.
- C. Moisture Content: Plus or minus 2 percent of optimum. Test in accordance with ASTM D6938.

3.8 FIELD QUALITY CONTROL TESTING

- A. Maximum Laboratory Density: Determined in accordance with AASHTO T180, Method D for A-1 soils and AASHTO T99, Method D for other soils Test for each type of soil encountered on site.
- B. Establish roller patterns necessary to achieve density indicated in Compaction Schedule at end of this Section.
- C. Density Tests: Perform in accordance with ASTM D6938.
 - 1. Frequency: Take minimum of one density test per lift for each 100 linear

feet of trench (per City standards) and take minimum of one density test per lift for each road crossing.

2. Acceptance: Average density equals or exceeds density indicated in Compaction Schedule at end of this Section. Reject single density tests greater than 4 percent below specified density.
3. If tests indicate Work is not acceptable, re-compact and retest. If necessary, remove and replace Work.

3.9 PROTECTION OF FINISHED WORK

- A. Protect utilities and improvements indicated to remain from damage.
- B. Protect bench marks and survey control point from damage or displacement.
- C. Protect finished Work from damage.
- D. Reshape and re-compact trenches subjected to vehicular traffic during construction.

3.10 COMPACTION SCHEDULE

- A. Non Traveled Areas: Compact backfill to minimum 90 percent of maximum laboratory density. Includes trenches in landscape areas and unimproved areas.
- B. Traveled Areas and Structures: Compact backfill to minimum 96 percent of maximum laboratory density. Includes trenches below structures, sidewalks, roads, parking lots, driveways and access roadway.

END OF SECTION

SECTION 33 10 00
PIPING MATERIALS AND COMPONENTS

PART 1 - GENERAL

1.01 SCOPE

This section covers the work necessary for furnishing, installing and testing the sewer line piping.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE

- A. Ductile iron pipe shall conform to the requirements of the AWWA C151 and AWWA C150. Pipeline thickness rating shall be minimum Class 51 for pipe larger than 12" diameter, and Class 350 for pipe 12" diameter and smaller, unless otherwise noted on the drawings. The pipe shall be provided with rubber gaskets, specials, and fittings as required. Nominal pipe laying lengths shall be 20-feet.
- B. Buried Ductile Iron Pipe shall be encased with 8 mil (minimum), Group 2, Class C polyethylene, conforming to the requirements of AWWA C105. The polyethylene encasement shall be overlapped across each pipe joint according to Installation Method A per AWWA C105. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, Polyken #900, 3M Scotchrap 51, or approved equal, to completely seal the seam.
- C. Ductile Iron Fittings. Ductile iron fittings shall conform to the "American National Standard for Gray Iron and Ductile Iron Fittings for Water and Other Liquids" (ANSI/AWWA C110) and be NSF approved. All buried fittings shall be completely coated with food grade grease, Chevron FM Grease, or approved equal, and shall be completely encased with 8 mil (minimum), Group 2, Class C polyethylene, conforming to AWWA C105 and color to match the pipe wrap. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, Polyken #900, 3M Scotchrap 51, or approved equal, to completely seal the seam.
- D. Ductile Iron Pipe Joints. Ductile iron pipe shall be furnished with mechanical joints, flanged joints, flexible couplings as required and shall conform to the "American National Standard for Rubber-Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings" (ANSI A21.11 AWWA C111) and the "American National Standard for Flanged Cast Iron and Ductile Iron Pipe with Threaded Flanges" (ANSI A21.15 AWWA C115).
- E. Restrained joints shall conform to the requirements of AWWA C151. Joint restraints for pipe-to-pipe connections shall be Megalug Series 1700 by EBAA

Iron for push-on joints or Megalug Series 1100 by EBAA Iron for mechanical joints, or approved equal. Joint restraints for fittings and bends shall be Megalug Series 1100 by EBAA Iron, or approved equal.

- F. Cement Mortar Lining. Ductile iron pipe and fittings shall be lined with cement mortar in accordance with the requirements of the "American National Standard for Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and fittings for Water" (ANSI A21.4 AWWA C104) except that lining thickness shall be not less than 3/16 of an inch for pipe smaller than 24-in diameter and 1/4 of an inch for pipe 24-in diameter and larger.

2.02 PVC PIPE (PRESSURIZED)

- A. All polyvinyl chloride (PVC) pipe in pressure pipeline systems shall be manufactured of material conforming to AWWA C900, ASTM D1784, and cell classification 12454A PVC materials for the size and class required. Standard laying lengths shall be 20-feet. Pipe sections shall be clearly marked to:
1. Identify manufacturer's name or trademark
 2. Nominal pipe size and OD base
 3. AWWA material code designation
 4. Dimension ratio
 5. AWWA pressure class
 6. AWWA specification designation
 7. Product record code
- B. The PVC pipe shall be DR-18 (235 psi)
- C. All joints and accessories shall be as manufactured and furnished by the pipe supplier. Joints shall be bell and spigot conforming to the requirements of ASTM D3139. Gaskets shall comply with the requirements of ASTM F477.
- D. Deflection at the joint shall not exceed 1.0 degree for AWWA C900 pipe or the maximum deflection recommended by the pipe manufacturer. No deflection of the joint shall be allowed for joints that are over-inserted or not inserted to the assembly or stop mark.
- E. Joint restraints for fittings and bends shall be a Megalug system as manufactured by EBAA Iron, or approved equal. (RESTRAINTS WITH A POINT LOADING ON THE PIPE WILL NOT BE ALLOWED ON PVC PIPE.)

2.02 PVC PIPE (GRAVITY)

- A. PVC sewer pipe shall conform to the requirements of ASTM D 3034 for pipe sizes 3-inch to 15-inch and to ASTM F 679 for pipe sizes 18-inch to 48-inch. Material for PVC pipe shall conform to the requirements of ASTM D 1784, for cell classification 12454 or 12364 as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444.

- B. Joints shall conform to ASTM D 3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477 or ASTM F 913.
- C. Pipe sections shall be clearly marked to:
 - 1. Identify manufacturer's name or trademark
 - 2. Nominal pipe size and OD base
 - 3. ASTM material code designation
 - 4. Dimension Ratio
 - 5. ASTM specification designation
 - 6. Product record code
- D. The PVC pipe shall meet the testing in accordance with ASTM D 2412 and shall be (SDR 35)

2.04 SMALL STEEL PIPE

- A. Unless otherwise shown, galvanized steel pipe and black steel pipe in sizes 4 inches in diameter and smaller shall conform to the requirements of the "Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses" (ASTM A120), and shall be Schedule 40 standard weight. Galvanized steel pipe shall not be cement mortar lined unless otherwise shown. Fittings for galvanized steel pipe shall be of galvanized malleable iron.

2.05 BRASS PIPING

- A. Brass piping shall be iron pipe size standards and meet ASTM B-43 standards for Seamless Red Brass Pipe.

2.06 GASKETS AND BOLTS

- A. Except as otherwise provided, gaskets for flanged joints shall be 1/8-inch thick rubber fabric. Gaskets shall be U.S. Pipe Flange-Tyte, or approved equal. Wherever blind flanges are shown, the gaskets shall consist of 1/8-inch thick cloth-inserted rubber sheet which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.
- B. All buried fittings shall have stainless steel nuts and bolts with Teflon coated nuts.

2.07 SAFETY TAPE

- A. Safety tape shall be a minimum of 3" wide by 5.0 mil overall thickness, with no less than a 50 gauge solid aluminum foil core. It shall be Green in color and shall be clearly labeled with the word "SEWER". Safety tape shall be as manufactured by Magnatec or approved equal.

2.08 TRACER WIRE

- A. All sewer lines shall be installed with tracer wire conforming to the following:
1. 12 gauge, 600 volt copper wire (PVC jacketed for underground services)
 2. Secure wire to pipe at 20-ft minimum intervals
 3. Install wire continuously along the pipe alignment and at all service connections.
 4. Wire shall be looped at all cleanouts and manholes.
 5. The tracer wire installation shall be subject to Owner inspection prior to backfilling of trenches.
 6. Prior to District acceptance of the sewer system, the Contractor shall demonstrate to the District that the tracer wire is in a operable condition to the satisfaction of the District. In the event that the wire is not operable the contractor shall determine the cause of discontinuity, fix the problem and test at no additional cost to the owner or District.

2.09 PIPE COATINGS

- A. All exposed piping, valves, and fittings including lift station shall be painted as specified in Section 09 91 00 – Painting and Finishes. Exposed piping, valves and fittings to be painted shall be primed by the manufacturer in preparation for painting. CONTRACTOR shall provide verification from the finish coating supplier that the field applied coatings are compatible with the manufacturer's prime coat. Pipe to be painted shall not have asphalt emulsion coating. The exterior of buried pipe and fittings shall be an asphaltic coating approximately one-mil thick.

PART 3 - EXECUTION

3.01 PIPE PREPARATION AND HANDLING

- A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
- B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

3.02 CUTTING PIPE

- A. General. Cut pipe for inserting valves, fittings, closure pieces, and as otherwise required, in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe.
- B. Steel Pipe. As far as practicable, all steel pipe shall be furnished in the proper length in accordance with the reviewed shop drawings. If cutting of the steel pipe is required in the field, cut with wheel type pipe cutter. Do not cut with flame or hacksaw.
- C. Dressing Cut Ends. Dress cut ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections which may damage the rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer. Dress cut ends of welded steel pipe for field welding by beveling in accordance with AWWA C20. Dress cut ends of pipe for flexible couplings or flanged coupling adapters as recommended by the coupling or adapter manufacturer.

3.03 LAYING BURIED PIPE

- A. All buried pipe shall be prepared as hereinbefore specified and shall be laid on the prepared base and bedded to insure uniform bearing. No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable. Joints shall be made as herein specified for the respective types. Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling. Where the pipe is connected to concrete structures, the connection shall be made as shown. If the connection is not shown, make connection such that a standard pipe joint is located no more than 18 inches from the structure.

3.04 DUCTILE IRON PIPE POLYETHYLENE ENCASEMENT

- A. Buried Ductile Iron pipe and fittings shall be polyethylene encased in accordance with the requirements of AWWA C105 Method A. Remove all lumps of clay, mud, cinders, etc. on the pipe surface before installation of the encasement. During installation, soil or embedment material shall not be trapped between the pipe and the polyethylene. Cut polyethylene tube to a length at least 2 feet longer than the pipe section. Wrap shall overlap the adjacent pipe joint at least 1 foot. After assembling the pipe joint, overlap the joint with the polyethylene tube and secure to the pipe with adhesive tape completely around the seam. Overlap the joint on the previous pipe with the polyethylene tube and secure to the existing wrap with adhesive tape and completely seal the seam. Take up the slack width at the top of the pipe to make a snug but not tight fit along the barrel of the pipe and secure with poly tape at 5 foot intervals. For installations below the water table or

wet areas, circumferential wraps of tape should be placed at 2 foot intervals along the barrel of the pipe prior to lowering the pipe into the trench.

3.05 THRUST BLOCKING

- A. Thrust blocks shall be installed at points where the pipe changes direction such as: at all tees, elbows, wyes, caps, valves, hydrants, reducers, etc.
- B. Thrust blocks shall be constructed so that the bearing surface is in direct line with the major force created by the pipe or fitting.
- C. Thrust blocks shall bear against solid undisturbed earth at the side and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints or the pipe or fitting.
- D. Thrust blocks shall be sized and constructed per District Standards or the drawings, whichever is greater.

3.06 PRELIMINARY CLEANING AND FLUSHING

- A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible, the flushing shall be made with an open pipe end.
- B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.07 INSPECTION AND TESTING OF PIPELINE

- A. See Section 308 – Acceptance Tests – Gravity Sewer Mains of the Jordanelle Special Service District “Design Standards, Construction Specifications and Standard Drawings” for details regarding testing of the sewer pipelines.
- B. Source of Water
 - 1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for flushing and/or pressure testing of the pipeline.
- C. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges and shall have a size and pressure range appropriate for the pipe being tested.
- D. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that the ENGINEER may be present during the test

END OF SECTION 33 10 00

SECTION 33 12 16
WATER VALVES AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the work necessary for furnishing and installing gates, valves, and miscellaneous equipment.

PART 2 - PRODUCTS

2.1 PLUG VALVES

- A. Plug valves shall be of the non-lubricating, eccentric type and shall be designed for a working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Valves shall provide tight shut-off at rated pressure.
- B. Valves 20" and smaller shall have round port design. 24" and larger valves shall have rectangular port design. Minimum port area for all valves shall be 80% of corresponding pipe area.
- C. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable.
- D. The valve plug shall be cast iron ASTM A126 Class B, with Buna N resilient seating surface to mate with the body seat.
- E. Valve flanges shall be in strict accordance with ANSI B16.1, Class 125.
- F. Plug valve shall be furnished with permanently lubricated sleeve type bearings conforming to AWWA C504. Bearings shall be of sintered, oil impregnated type 316 stainless steel ASTM A-743 Grade CF-8M or bronze ASTM B-127.
- G. Valves shaft seals shall be of the "U" cup type, in accordance with AWWA C504. Seals shall be self adjusting and repackable without moving the bonnet from the valve.
- H. All exposed valves shall be provided with worm gear type manual actuators. All buried valves shall be provided with worm and gear actuators suited for the intended service.
- I. Valves shall be Flo-E-Centric manufactured by Flomatic or approved equal.

2.2 ELECTROMAGNETIC FLOWMETERS

A. Sensor.

1. The flow tube and liner material shall be constructed of a composite elastomer (hard and soft rubber) surrounded by two integral coils. Measurement and grounding electrodes shall be 316 stainless steel. Connecting flanges shall be carbon steel.
2. Operating Temp: -20 to +160° F
3. Submergence: The sensor terminal box shall be backfilled with a non-setting, transparent potting material for operation in a possible permanently submerged condition up to 30 feet.
4. Signal converter: Type MAG 5000
5. Enclosure: NEMA 4X-6 enclosure

B. Display

1. Background illumination with alphanumeric 3-line, 20-character display to indicate flow rate, totalized values, settings, and faults.
2. Power supply: 115/230 VAC or 11-24VDC
3. Operating temperature: -5 to +120 degrees F
4. Outputs: 0-20 mA or 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1 A. Digital (frequency or pulse) for external display of flow rate or totalizer
5. Communications: Optional HART available

C. Sensor and signal converter performance

1. Flow Range: 1.5 fps to 33 fps for accuracies stated below.
2. Accuracy: 0.5% of actual flow
3. Separation: Maximum distance of 900 feet between signal converter and sensor without the use of any additional equipment
4. Bi-directional flow capabilities shall be standard

D. Totalizer: Two eight-digit counters for forward, net, or reverse flow

E. The electromagnetic flow meter shall be a Siemens Model MAG 5100 W flow sensor with a Siemens MAG 5000 Flow Indicator Transmitter.

2.3 FLAPPER SWING CHECK VALVES

- A. Rubber flapper swing check valves shall meet the requirements of AWWA C508. The valve shall be provided with flanges in accordance with ANSI B16.1, Class 125. The valve body shall be full flow equal to the nominal pipe diameter at all points through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. The valve shall be provided with a backflow device, disc closure accelerator, and position indicator.

- B. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. The disc shall be precision molded Buna-N (NBR) ASTM D2000-BG. The disc accelerator shall be stainless steel.
- C. The check valve shall be Surgebuster Series by Valmatic, or approved equal.

2.4 BALL VALVES

- A. Ball Valves shall be full port opening stainless steel and have adjustable stem packing gland. They shall be Watts Series S-FBV-1 or approved equal.

2.5 STAINLESS STEEL PIPING

- A. Stainless steel piping shall be iron pipe size standards and meet ASTM A-312 standards.

2.6 PRESSURE GAGES

- A. Pressure gauges shall be provided where shown. Gauges shall be industrial type with stainless steel movement, liquid filled, and stainless steel or Phenolic case. Unless otherwise shown, pressure gauges shall have a 4-1/2 inch dial and 1/2 inch threaded connection. Gauges shall be calibrated to read in applicable units, with an accuracy of ± 1 percent, to 150 percent of the working pressure. Gauges shall be manufactured by U.S. Gauge, Foxboro, Marsh, or equal.

2.7 PIPE SUPPORTS

- A. Pipe supports shall be manufactured by Anvil International, Inc., and shall be Anvil Adjustable Pipe Saddle Support Model No. 264 or Model No. 265 as designated on the drawings (or approved equal).

2.8 HOSE BIBBS and SAMPLING TAPS

- A. Hose bibbs shall be as-manufactured by Watts, or approved equal, and shall include anti-siphon devices. Hose Bibbs shall include anti-siphon devices. Sampling Taps shall be smooth nose type.

PART 3 - EXECUTION

3.01 GENERAL

- A. Before installation, carefully clean valves of all foreign material, adjust stuffing boxes, and inspect valves in open and closed positions. Install valves in accordance with the applicable portions of these Specifications.
- B. Unless otherwise indicated, install valves with the stem vertical. Mount horizontal valves in such a manner that adequate clearance is provided for operation. Installation practices shall conform to manufacturer's recommendations.

- C. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert the gasket and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen the nuts, reseal or replace the gasket, re-tighten the nuts, and retest the joint. Joints must be watertight at test pressures before acceptance.

3.02 BURIED VALVE OPERATORS

- A. Where buried valves are indicated, CONTRACTOR shall furnish and install valve boxes to 3-inches above grade in unimproved areas, or at grade with concrete collar in improved areas. All valves and gates shall be new and of current manufacture.
- B. Concrete Collars shall be installed for all buried valves and shall be 10" thick x 2'-6" in diameter centered over the valve box. They shall have two circumscribing #4 bars, one at three inches from the outside edge and a second bar nine inches from the outside edge each centered in the concrete.

END OF SECTION 33 12 16

SECTION 41 22 13
OVERHEAD MONORAIL HOIST

PART 1 GENERAL

1.1 DESCRIPTION

- A. CONTRACTOR shall furnish and install a top running single overhead hoist monorail with appurtenances, complete and operable, as specified in the Drawings and Contract Documents.
- B. CONTRACTOR shall review the building heights and dimensions and verify the proposed monorail dimensions provide the required clearances.
- C. The CONTRACTOR shall furnish the materials and labor for the following items:
 - 1. Detailed design of monorail system, including beam, trolley, hoist, cabling, controls, and all appurtenances specified herein.
 - 2. All material necessary for complete installation of the monorail
 - 3. Complete controls
 - 4. Equipment installation, maintenance, and operating instructions
 - 5. Drawings and parts lists as specified
 - 6. Load test and certification of monorail after installation.
- D. CONTRACTOR shall furnish the materials and labor for the following:
 - 1. Complete erection of the monorail system
 - 2. Supporting steel for the monorail beam
 - 3. Electric festoon system (power to the hoist)

1.2 REFERENCES AND STANDARDS

- A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Crane Manufacturers Association of America (CMAA)
 - 1. CMAA #74 Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley
- C. American Society for Testing and Materials (ASTM)
 - 1. ASTM A 36 Standard Specification for Carbon Structural Steel
 - 2. ASTM A 992 Standard Specification for Structural Steel Shapes
- D. American Society of Mechanical Engineers (ASME)
 - 1. ASME B30.10 Hooks
 - 2. ASME B30.11 Monorails and Underhung Cranes

- 3. ASME B30.16 Overhead Hoists (Underhung)
- E. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electric Code
- F. Occupational Safety and Health Administration
 - 1. Part 1926.554 Overhead Hoists

1.3 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 – Submittals.
- B. Submit drawings indicating required clearances, end approaches, horsepower, and full load current rating of all motors and wheel loading.
- C. Submit electrical single line diagrams, schematic interconnection diagrams, and control diagrams.
- D. Submit manufacturer's name, catalog/model number, and data sheets of any equipment to be furnished not manufactured by vendor.
- E. Submit any exception or difference of any equipment to be furnished from that specified and reason for the substitution.
- F. Provide the name and address of manufacturer's representative nearest plant site maintaining 24-hour service facilities and complete stock of spare parts.
- G. Submit installation, operation, and maintenance manuals. Include as-built drawings and test results.

1.4 WARRANTY

- A. Vendor shall warranty materials and workmanship of equipment installed under these specifications for a period of one year after installation.

PART 2 PRODUCTS

2.1 OPERATING CONDITIONS

- A. Hoist Capacity – 1/2 ton
- B. Total Lift – 18 feet
- C. Operating Speeds
 - 1. Hoist: 15 feet per minute
- D. Type of Control

1. Pendant shall be suspended from the trolley.
2. Pendant shall hang 48 inches above the lowest level floor.

E. Type of Service

1. Crane: CMAA Crane Service Class C.
2. Hoist: HST-4M, H4

F. Heights

1. Operating floor to hook in high position: 17.5 feet

G. Length of Monorail beam: 12 feet

H. Ambient Temperature: 50 to 100 degrees Fahrenheit

- I. Electrical power characteristics: Power for operating the equipment will be supplied by a 480 volt, three phase, 60 Hz circuit.

2.2 HOIST MONORAIL BEAM

- A. Hoist monorail support steel, beam and hoist end stops will be provided by building contractor. The beam will be designed with sufficient strength and rigidity to prevent undue lateral or vertical deflection for the wheel loading of the hoist. The rail will be installed straight, parallel, and level, at the same elevation and center-to-center distance as specified above. The rail will be standard ASCE sections as specified by vendor.

2.3 TROLLEY

- A. A monorail type trolley shall be furnished to support the equipment and operate on the beam.
- B. Hardened tread wheels with anti-friction bearing shall be provided.
- C. The trolley shall be manually driven.
- D. The trolley frame shall be steel conforming to the requirements of ASTM A 36. It shall be of rigid construction designed to transmit the imposed load to the bridge girder without under deflection.
- E. Safety lugs shall be furnished on each trolley.

2.4 HOIST

- A. Hoist shall be a low headroom, heavy duty, industrial type standard chain hoisting machine of proper capacity mounted to the trolley. It shall consist of a motor, hoist drum, sheaves, load block, hook, and hoisting rope. An electric brake shall be supplied on the hoist.

- B. The motor shall be designed specifically for hoisting duty. The electric brake shall be of suitable size to promptly stop the motor rotation in either direction, and hold the load.
- C. Precision cut, full depth teeth, heat treated forged steel gears shall be used in the gear reducer. These gears shall be provided with oil bath lubrication and enclosed in a drip proof case
- D. A loading limit control device shall be provided to prevent over stressing the system. This device shall de-energize the hoist motor and immobilize the up-circuit when an over capacity lift is attempted. This switch must be set to overcome dynamic loading conditions but not exceed 125% rated capacity.
- E. Geared upper and lower limit switches shall be furnished to restrict motion beyond the normal operating travel. These switch contacts shall be connected in the respective motor control circuits.
- F. The load block shall be of the enclosed type and equipped with a swivel type safety latch hook.
- G. Hoist and Trolley manufacturer, or approved equal:
 - 1. Harrington
 - 2. Saturn
 - 3. Stahl
 - 4. Acco

2.5 MOTORS

- A. All motors shall be totally enclosed fan cooled induction type with Class “B” insulation. They shall be 480 volts, three phase, and rated for 20 min continuous operation under full load with a temperature rise not to exceed 10 degrees Fahrenheit above an ambient temperature of 70 degrees Fahrenheit.

2.6 CONTROL STATION

- A. A pendant type button push-button station shall be provided to control the motions of the hoist.
- B. Pendant push-button station shall include a twist on & push off switch; maintained pressure pendant raise and lower buttons, and a maintained pressure bypass button.
- C. The pendant shall have complete control of all hoist functions including turning power on and off and pendant up/down control.
- D. The push-button station shall be suspended on a cable from the hoist 4 feet above the operating floor level from the bottom of the station.
- E. The push-button enclosure shall be of lightweight construction in accordance with the vendor’s standard.

2.7 CURRENT CONDUCTORS

- A. A 4-conductor, flat, neoprene insulated, festooned flexible cable shall be provided along the monorail to supply electric power to the hoist. Three of these conductors will be used to supply electric power. The remaining conductor will be used for equipment grounding. The cable shall be connected to a terminating box at one end of the beam.

2.8 HOIST CONTROL

- A. All single motions shall be controlled by across-the-line, reversing type motor starters.
- B. The control circuit voltage shall not exceed 120 volts. This voltage shall be supplied from a dry type transformer of proper capacity. The primary leads of this transformer shall be connected across the “L1” and “L2” lines of power service. The X2 line of the transformer secondary shall be grounded and adequate fuse protection supplied in the ungrounded X1 line.
- C. Fuse or circuit breaker protection shall be furnished for each individual hoist motor.
- D. Forward and reverse motor contactors must be interlocked mechanically and electrically to prevent motor damage if the operator pushes the direction buttons simultaneously.

2.9 ELECTRICAL WIRING

- A. The complete electrical installation shall be made in accordance with the National Electric Code requirements and the conditions outlined above.
- B. All electrical equipment shall be mounted in NEMA Type 3R, or better, enclosures.
- C. All wiring connections within the electrical control enclosures shall be made with 600 volt, 90 degrees Celsius machine tool wire. Wiring connections between control enclosures and other electrical devices shall be made with 600 volt type THWN conductors and run in rigid conduit. Flexible metal conduit may be used to devices requiring position adjustment or run less than three feet. All wiring connections to electrical equipment in control enclosures shall be terminated on terminal strips with lugs or spades and properly identified.
- D. Conduits shall be terminated at all enclosures and boxes in drilled holes or knockouts. Conduits one-inch and smaller shall be fastened to the enclosure by the use of dished type lock nuts with trailing knife edge. Conduits 1-1/4 inch and larger shall be terminated in a threaded hub or an **Appleton HUB**, or approved equal fitting inserted in a drilled hole knockout. Insulated bushings shall be furnished on all conduit terminations. Threaded conduit fitting shall be issued for all other connections.
- E. A grounding system shall be furnished to effectively maintain the enclosures of all electrical equipment such as motors, brakes, starters, push button stations, boxes, etc., at zero potential. Rigid conduit will provide adequate grounding continuity between enclosures when installed as noted above.

- F. Vendor is to specify, as part of his design, total connected load (kVA) and maximum expected load current (amperes.) Also, the vendor is to recommend feeder size and fuse size.
- G. All labels and nameplates must be machine produced. Handwritten labels are not acceptable.

2.10 EQUIPMENT DESIGN SAFETY

- A. All equipment furnished to vendor's standard design, which incorporates weldments, is to be welded in accordance with the appropriate codes and standard of the American Welding Society.
- B. All equipment non-standard design to fulfill special requirements shall, in addition, meet the following:
 - 1. All critical welds, the failure of which would cause potential accidents or injuries to personnel, are to be executed with special attention as outlined in this section.
 - 2. An audit is to be made by the vendor to determine those welds to be in the critical category. Such welds are to be given special attention by the vendor to ensure adequate quality control.

2.11 INSPECTION AND TESTS

- A. Inspection by OWNER, ENGINEER, and CONTRACTOR during fabrication shall be permitted by the vendor. These inspections shall be performed to determine the general adherence to these specifications and, in particular, to determine the quality of welding and painting provided.
- B. Final acceptance will be made after the entire installation has been completed and a satisfactory trial has been made. All tests required to prove the ability of the hoist shall be made by the hoist manufacturer with CONTRACTOR present.

2.12 GENERAL

- A. Any other requirements not set forth in these specifications, but necessary for the safe and reliable operation of the equipment, shall be included.

2.13 LABELING

- A. Hoist shall be labeled with load rating.

PART 3 EXECUTION

3.1 INSTALLATION AND INSPECTION

- A. Inspect structure and monorail erection for conformance with reviewed shop drawings and contract documents prior to installation of equipment. Bring nonconforming work to

the attention of the customer prior to proceeding with hoist installation. Non-conforming runway structure or installation must be corrected prior to load testing of hoist system. Costs of delays or additional work due to nonconforming runway structure will not be reimbursed by OWNER.

3.2 TESTING

- A. All monorail hoist equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the trolley to determine that the equipment shall perform smoothly and safely and that pendant cable length is sufficient to permit operation from desired floor levels. All tests shall be carried out with the monorail hoist equipment loaded at 125 percent of capacity. CONTRACTOR shall provide the test weight loads. Any defects shall be corrected by the monorail hoist provider without any expense to OWNER.

3.3 USE BY CONTRACTOR

- A. If monorail hoist is used by CONTRACTOR, it shall be repaired, repainted, and otherwise refurbished to like new condition prior to its acceptance. CONTRACTOR assumes all responsibility for operation and maintenance until the monorail hoist has been accepted by OWNER.

3.4 CLEANUP

- A. Upon completion of work, area shall be cleaned and restored to original condition, acceptable to OWNER.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. 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 supports for multiple pipes 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.
 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

- B. 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.

- C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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 (DN 65) 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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.

3.3 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.

3.4 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 (40 mm).

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 a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.**
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. 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 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

- a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
- 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Steel Support 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.
- 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.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 - 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 3. Coating: PE with flame retardant.

- a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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: 50 or less.
 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 7. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type L (ASTM B 88M, Type B).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
- D. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated, and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Transition Service-Line Risers: Factory fabricated, and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.

- b. Outlet shall be threaded or suitable for welded connection.
- c. Bridging sleeve over mechanical coupling.
- d. Factory-connected anode.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
- 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
- 4. Corrugated stainless-steel tubing with polymer coating.
- 5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

- 1. Copper-alloy convenience outlet and matching plug connector.
- 2. Nitrile seals.
- 3. Hand operated with automatic shutoff when disconnected.
- 4. For indoor or outdoor applications.
- 5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller.
- 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig (862 kPa).

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 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. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated brass.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig (4140 kPa).
 - 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - f.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.

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. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. PE Ball Valves: Comply with ASME B16.40.

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. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig (552 kPa).
8. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

H. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eclipse Combustion, Inc.
 - d. Goyen Valve Corp.; Tyco Environmental Systems.
 - e. Magnatrol Valve Corporation.
 - f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
 - g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
3. Pilot operated.
4. Body: Brass or aluminum.
5. Seats and Disc: Nitrile rubber.
6. Springs and Valve Trim: Stainless steel.
7. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
8. NEMA ICS 6, Type 4, coil enclosure.
9. Normally closed.
10. Visual position indicator.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Vanguard Valves, Inc.
3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
4. Maximum Operating Pressure: 5 psig (34.5 kPa).
5. Cast-aluminum body with nickel-plated chrome steel internal parts.
6. Nitrile-rubber valve washer.
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Wall mounting bracket with bubble level indicator.

B. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Pacific Seismic Products, Inc.
3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
4. Maximum Operating Pressure: 0.5 psig (3.45 kPa).
5. Cast-aluminum body with stainless-steel internal parts.
6. Nitrile-rubber, reset-stem o-ring seal.
7. Valve position, open or closed, indicator.
8. Composition valve seat with clapper held by spring or magnet locking mechanism.
9. Level indicator.
10. End Connections: Threaded for valves NPS 2 (DN 50) and smaller.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
7. Orifice: Aluminum; interchangeable.
8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
10. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Overpressure Protection Device: Factory mounted on pressure regulator.
12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
13. Maximum Inlet Pressure: 10 psig (69 kPa).

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Canadian Meter Company Inc.
 - b. Eaton Corporation; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.
3. Body and Diaphragm Case: Die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
9. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
10. Maximum Inlet Pressure: 5 psig (34.5 kPa).

2.8 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International Ltd.
 - e. Matco-Norca, Inc.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.2 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).

2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

3.6 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.8 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
 2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and flared joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Annealed-temper copper tube with wrought-copper fittings and flared joints.
 - 3. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.11 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground: PE valves.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION 231123

SECTION 235533 - FUEL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gas-fired unit heaters.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Lennox Industries, Inc.
 - 2. Modine Manufacturing Company.
 - 3. Reznor/Thomas & Betts Corporation.
 - 4. Sterling HVAC Products; Div. of Mestek Technology Inc.
- D. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
- E. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- F. Type of Venting: Powered vented.
- G. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
- H. Heat Exchanger: Stainless steel.
- I. Burner Material: Stainless steel.
- J. Unit Fan: Propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
- K. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 1. Gas Control Valve: Single stage.
 - 2. Ignition: Electronically controlled electric spark with flame sensor.
 - 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 - 4. Vent Flow Verification: Differential pressure switch to verify open vent.
 - 5. Control transformer.
 - 6. High Limit: Thermal switch or fuse to stop burner.
 - 7. Thermostats: Devices and wiring are specified in Section 230900 "Instrumentation and Control for HVAC."
 - 8. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
 - 9. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

10. Thermostat: Single-stage type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.
 11. Thermostat: 2-stage type with duct-mounting sensor and 50 to 90 deg F (10 to 32 deg C) operating range.
- L. Discharge Louvers: Independently adjustable horizontal blades.
- M. Accessories:
1. Vertical discharge louvers.
 2. Discharge Nozzle: Discharge at 25 to 65 degrees (0.44 to 1.13 radians) from horizontal.
 3. Four-point suspension kit.
 4. Summer fan switch.
 5. Unit-mounted thermostat bracket.
 6. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
 7. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes and flashing for wall or roof penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Install and connect oil-fired unit heaters and associated fuel and vent piping according to NFPA 31, applicable local codes and regulations, and manufacturer's written installation instructions.
- C. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
- D. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.
- E. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- F. Fuel Oil Piping: Comply Section 231113 "Facility Fuel-Oil Piping." Connect to fuel oil supply and return piping with shutoff valve and union at each connection.
- G. Vent Connections: Comply with Section 235100 "Breechings, Chimneys, and Stacks."
- H. Electrical Connections: Comply with applicable requirements in electrical Sections.
 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

- I. Adjust initial temperature set points.
- J. Adjust burner and other unit components for optimum heating performance and efficiency.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 235533

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all electrical aspects of the work.

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 REFERENCES

A. The installation and commissioning of the Electrical System shall conform to all applicable codes, regulations, standards and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. National Electric Code (NEC).
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. American National Standards Institute (ANSI)
6. American Society for Testing and Materials (ASTM)
7. Insulated Cable Engineers Association (ICEA)
8. National Electrical Manufacturers Association (NEMA)
9. Federal Occupational Safety and Health Act (OSHA)
10. Underwriters Laboratories, Inc. (UL)
11. International Society of Automation (ISA)

1.3 DEFINITIONS

A. Refer to the Contract Drawings sheet E001 for a list of abbreviations associated with the Electrical System. In addition, the following definitions are used in this section:

1. AHJ – Authority Having Jurisdiction
2. I&C – Instrumentation and Controls
3. IS – Instrumentation Supplier
4. NEC – National Electric Code
5. VFD – Variable Frequency Drive
6. UL - Underwriters Laboratories, Inc.

1.4 ELECTRICAL SYSTEMS REQUIREMENTS

- A. Work provided outside of Contractor's scope:
 - 1. The following equipment is being furnished by the Owner:
 - a. PLC Panel, to be installed and wired by contractor.
- B. The Work is to provide all labor and materials necessary for erecting a complete and operational Electrical System, tested and ready for continuous use as described by the Contract Documents. The Electrical System shall be constructed in accordance with the Contract Documents, and Federal, State, and Local codes and regulations. In addition, the Work shall adhere to the following general provisions:
 - 1. The Electrical Contractor shall obtain all necessary permits required by the AHJ. In addition, the Electrical Contractor shall ensure that all inspections required by the AHJ are coordinated, conducted and documented.
 - 2. All work shall be completed in a neat, workmanlike manner in accordance with the latest NEC standards of installation under competent supervision.
 - 3. The Electrical Contractor shall visit the job site prior to bidding to become familiar with existing conditions and other factors, which may affect the execution of the work. Include all related costs in the initial bid proposal.
 - 4. Coordinate work with the utilities providing services on this project. This may include but is not limited to the electric utility, telephone utility, cable TV/Internet utility. All electrical work associated with utilities shall be provided and installed per the utility requirements.
 - 5. All materials shall be new and of the best quality, manufactured in accordance with the requirements listed in part 1.2 of this section. The Contractor shall furnish and install the parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.
 - 6. Protect all electrical material and equipment that is being stored or has been installed against damage by other trades, weather conditions, or any other preventable causes. Equipment damaged during shipping, storage or construction, prior to acceptance by the engineer or the owner, will be rejected as defective.
 - 7. Leave the site clean. Remove all debris, empty cartons, tools, conduit, wire scraps and all miscellaneous spare equipment and materials used in the work during construction. All components shall be free of dust, grit and foreign materials, left as new before final acceptance of work. Damaged paint and finishes shall be touched up or repainted with matching color paint and finish.
 - 8. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature and altitude as described in part 2.4 of this section. Electrical equipment not rated for operation at that temperature shall be provided with heating and/or air conditioning to meet the manufacturers' operating temperature.

9. If any contradictions, contrasts, non-homogeneity, or inconsistency appears, the strictest criteria noted and the collective requirements in any and all of the Contract Documents shall apply.
 10. The Electrical Contractor shall perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. The Electrical Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.
- C. In order to provide a complete system, oversee and coordinate with all electrical equipment and services being provided outside of Contractor's scope.
1. The Engineer is responsible to ensure that equipment being supplied by others related to the electrical system complies with the requirements of the Contract Documents
 2. The Electrical Contractor is responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.
- D. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the Electrical Contractor's scope.
1. Inform all vendors and suppliers providing equipment related to the Electrical System the requirements of Division 26.
 2. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 26.
 3. If a vendor or supplier is unable to meet the requirements of Division 26, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.
- E. Prepare Electrical System Submittals as required by Division 26 and Section 013300. Coordinate with the IS and the requirements of Division 40 to ensure that all equipment being supplied by the Electrical Contractor and/or IS has been submitted.
- F. Oversee the installation of the Electrical System.
- G. Actively participate in loop testing as outlined in Division 40.
- H. Actively participate in commissioning as outlined in Division 40.
- I. Maintain record drawings.
1. Maintain on the construction site a set of the Electrical Drawings that shall be continuously marked up during construction.
 - a. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
 - b. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.

- J. Prepare O&M manuals.
 - 1. Provide O&M manuals in accordance with Section 017823.
- K. Provide training on electrical equipment that has been installed.

1.5 ACTION SUBMITTALS

- A. General
 - 1. Submittals for Division 26 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
 - a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.
 - b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
 - c. Show product dimensions, construction and installation details, wiring diagrams, and specifications.
 - d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.
 - 2. Furnish submittals required by each Section within Division 26.
 - 3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.
- B. Recommended Spare Parts Submittal
 - 1. Submit a list of spare parts for all of the equipment associated with the Electrical System. The list of spare parts shall include list pricing for each item.
 - 2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
 - 3. Indicate whether or not the spare parts are being provided under this contract or not.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

- A. All equipment supplied for this project shall meet the requirements of the NEC and shall be listed by and bearing the label of the UL.
- B. The Electrical Contractor shall be a company that has been actively involved in the installation and commissioning of Electrical Systems for a minimum period of five years.
- C. The Electrical Contractor shall have adequate facilities, manpower and technical expertise to perform the Work associated with the Electrical System and as outlined by the Contract Documents.

- D. The Electrical Contractor shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The Electrical Contractor company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS AND METHODS

- A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged or dirty materials, equipment, and parts are not considered to be new and unused and will not be accepted.
- B. Field verification of scale dimensions on Plans is directed, since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical, and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust their work to conform to the conditions indicated therein.
- C. The fabricator of major components, such as distribution panelboards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein. Where possible, the major components shall be manufactured and supplied by the same fabricator.

2.2 AREA DESIGNATIONS

- A. Materials, equipment, and parts comprising any unit, or part thereof shall be rated for the area in which it is installed.

2.3 MANUFACTURERS

- A. All equipment provided for the Electrical System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.
- B. Refer to various Division sections for individual equipment manufacturers. Indicated manufacturers are subject to strict compliance with the specifications and complete project documents. The reference to a particular manufacturer does not relieve the Electrical Contractor from conforming to the specified requirements.
- C. When providing like electrical components they shall be furnished by a single manufacturer and shall be consistent throughout the project. For example, a 20A 2-way light switch in one building should match a 20A 2-way light switch in another building in both make, model and features.

2.4 EQUIPMENT ASSEMBLIES

- A. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly

will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

- B. Custom fabricated electrical control panels, and enclosures shall bear a serialized UL label affixed by a local inspector, and the serial number shall be submitted with the assembly record shop drawings.

2.5 OPERATING CONDITIONS

- A. The Electrical System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
 - 1. Environment: Wastewater Lift Station.
 - 2. Temperature Extremes: -4°F to 104°F (Outdoors); 40°F to 104°F (Indoors).
 - 3. Relative Humidity: 20% to 90%, non-condensing.
- B. Indoor and outdoor electrical equipment shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain electrical devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Electrical equipment in hazardous areas shall be suitable for and rated for use in the particular hazardous or classified location in which it is to be installed.

2.6 SEISMIC RESTRAINT

- A. The construction area is classified by the International Building Code (IBC) as Seismic Class C. The Code requires that not only the structures, but also major electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Guidelines for Seismic Restraints of Electrical Systems".
- B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.
- C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.
- D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.
- B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.
- C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.
- D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER'S SERVICES

- A. Manufacturer's services shall be furnished for the following equipment:
 - 1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
 - 2. Equipment that is equipped with VFD's
 - 3. Electrical generation equipment

3.3 INSTALLATION

- A. The Electrical System indicated throughout the design is diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

- B. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.
- C. The alignment of equipment and conduit shall be adjusted to accommodate architectural changes, or to avoid work of other trades, without extra expense to the Owner.
- D. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.
- E. The Electrical Contractor shall layout and install electrical work prior to placing floors and walls. Furnish and install sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.
- F. The Electrical Contractor shall furnish and install inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, or other mounting hardware are improperly placed, or installed, the Contractor shall do necessary work, at their own expense, to rectify the errors.
- G. The Electrical System is integrally connected to I&C, mechanical and structural systems. Coordinate with these other disciplines the installation of these related components.
- H. Electrical equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.
- I. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.
- J. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.
- K. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

- A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

- B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
 - 1. Descriptions of test methods to be performed during the FAT.
 - 2. FAT Schedule and Procedure
 - 3. FAT Checklists that allow for sign-off and comments for each test method and procedure.
- C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
 - 1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
 - 2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.
 - 3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
 - 4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
 - 5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.
- D. Control Loop Test Methods: In order to demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
 - 1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
 - 2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
 - 3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
 - 4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.
- E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.
- F. All changes and/or corrections made during the FAT shall be noted on the checklists.
- G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

- A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

- A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.
- C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.
- D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.
- E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.
- F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
 - 1. Date of calibration
 - 2. Project Name.
 - 3. Tag Number.
 - 4. Manufacturer, model and serial number.
 - 5. Calibration data including range, input, output and measurement at each calibration point.
 - 6. Space for comments.
 - 7. Space for sign-off by party performing calibration.
- G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

- A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
 - 1. All associated equipment, conduit and wire has been permanently installed, terminated and inspected.
 - 2. All wiring has been properly pulled, terminated and labeled.
 - 3. Each wire has been tested with a point-to-point test.
 - 4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
 - 5. All instrumentation has been appropriately installed and calibrated.
 - 6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

- B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
 - 1. Loop Number and Description
 - 2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
 - a. Each power distribution circuit.
 - b. Each control circuit.
 - c. Each alarm circuit.
 - d. Each PLC input/output point.
 - e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
 - f. Each hard-wired and software interlock.
- C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.
- D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.
- E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.
- F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

- A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.
- B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified

report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

- D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.
- E. Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

- A. Provide training in accordance with Section 260000.
- B. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.
- C. As part of the Training Plan, submit a résumé for each individual to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.
- D. Each training session shall include a written agenda.
- E. The Contractor shall train the Owner's personnel on the maintenance, calibration and repair of instruments provided.
- F. Within 10 days after the completion of each session, the Contractor shall submit the following:
 - 1. A list of Owner personnel who attended the training.
 - 2. A copy of the training materials used during the session with notes, diagrams and comments.

END OF SECTION 260000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. All conductors, conductor insulation and multiconductor cables shall comply with NEMA WC 70.
- B. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded using colored tape. Conductors #6 AWG or smaller shall be THWN-2 or XHHW-2. Number 4 and larger shall be XHHW-2.
- C. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600V.

- D. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than #12 AWG, unless specifically noted on the Plans. Control wires shall be allowed to be #14 so long as there is appropriate protection (fuse or circuit breaker sized at 15A or less).
- E. Multi-conductor tray cables shall be rated 600 volts, listed by UL as Type TC cable or ITC for instrumentation cable only per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/Terminators shall be watertight and manufactured of the same material as the cabling system referenced elsewhere in division 26.
- F. Multi-conductor tray cables to be installed in classified areas shall be armored, rated 600 volts, listed by UL as Type MC-HL cable per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/terminators shall be rated for classified areas and submitted upon accordingly.
- G. All wiring shall be as indicated on the Plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.
- H. VFD Cable:
1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
 3. Comply with UL requirements for cables in direct burial or Classes I and II, Division 2 hazardous location applications.
- I. The following table describes the conductor color code that shall be followed:

	120/208VAC	480VAC	12VDC	24VDC	24VAC
Phase 1	Black	Brown			
Phase 2	Red	Orange			
Phase 3	Blue	Yellow			
Neutrals/Commons	White	White	Orange/White	Blue/White	Yellow/White
Ground	Green	Green	Green	Green	Green
Control	Red		Orange	Blue	Yellow

- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Insulated Wire Corporation
 2. Cablec Corporation

3. Okonite Company
4. Southwire Company
5. Or Approved Equal

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- B. Connectors and splices shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.
- C. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.
- D. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.
- E. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.
- F. Bare conductor splices in wet locations or below grade shall be of the exothermic type.
- G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Power Systems, Inc.
 2. O-Z/Gedney; EGS Electrical Group LLC.
 3. 3M; Electrical Products Division.
 4. Or Approved Equal

2.3 PULLING LUBRICANT

- A. All cables shall be properly coated with a water-based (wax-based is not acceptable) pulling compound before being pulled into conduits so as to prevent mechanical damage to the cables during installation. Lubricants shall be approved by the cable manufacturer for use with the cable being installed.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Polywater
 2. Ideal Aqua-Gel
 3. Or Approved Equal

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded for all sizes.
- B. Branch Circuits: Copper. Stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway
- B. Exposed Feeders and Branch Circuits: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.
- C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Metal-clad cable, Type MC shall be allowed in ceilings that are considered dry and non-corrosive areas.
- D. Feeders and Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- F. Class 1 Control Circuits: Type THWN-2, in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.
- G. Class 2 Control Circuits: Type THWN-2, in raceway. Power-limited tray cable shall be used where runs are to be in cable tray as shown on the drawings.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval. Conductor splices shall not be made in underground junction boxes or manholes unless specifically noted on the plans.
- C. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:
 - 1. As specifically indicated on the Plans.

2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity de-rated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
 3. When field conditions dictate, and written permission is obtained from the Engineer.
- D. Use manufacturer-approved pulling compound or lubricant when pulling conductors; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.
 - F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted above. 12VDC, 24VDC and 48VDC control circuits may be combined into one conduit. 120/208/240VAC control circuits shall be isolated from all DC control circuits. 277/480VAC circuits shall be isolated from all other voltages.
 - G. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.
 - H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
 - I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
 - J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
 - K. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
 - L. 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 and UL 486B.
 - M. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - N. Wiring at Outlets and Switches: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
- 3.4 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."

3.5 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."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
 - a. All conductors with voltages at 277V or higher and corresponding neutrals and grounds.
 - b. All conductors #8 and larger.
 - c. All motor leads and corresponding grounds.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Instrumentation cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

B. Related Sections

1. For structured cabling systems, including fiber optic cabling and CAT6 cabling refer to Section 409533.

1.2 DEFINITIONS

- A. 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.

1.3 ACTION SUBMITTALS

- A. Product Data:** For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.**

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications:** Member company of an NRTL.
- B. Surface-Burning Characteristics:** As determined by testing identical products according to ASTM E 84 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: 50 or less.
- 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
- B. Test each pair of each cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Conduit and Boxes: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 INSTRUMENTATION CABLE

- A. Instrument cable shall be Type TC (update to allow Belden gray TSP's) and have the number of individually shielded twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.
- B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.
- C. The conductors shall be tin-plated, soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.
- D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.
- E. Pairs installed in a cable tray shall have a UV resistant jacket and shall have a jacket intended for cable tray use.

2.3 RS-232 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. Polypropylene insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded tin-plated copper, Type THHN-THWN, in raceway, complying with UL 83.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.7 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brady Corporation.
 2. Panduit Corp.
 3. Or Approved Equal.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Pathway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be in these positions.
 - 3. Secure conduits to backboard if entering room from overhead.
 - 4. Extend conduits 3 inches above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 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. 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.
 - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. Installation of Control-Circuit Conductors:
 - 1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. 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 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication 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 Rating Less Than 2 kVA: A minimum of 12 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 24 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 48 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 6 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 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 Rating Less Than 2 kVA: 3 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
5. Separation between Cables and Electrical Motors and Transformers: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 6 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables.

3.4 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.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. For data communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- B. 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.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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. Stranded Conductors: ASTM B 8.
 - 2. Tinned Conductors: ASTM B 33.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 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.

2.2 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. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch in diameter and 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install stranded conductors all conductor sizes.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.
- C. 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.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded or approved compression 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 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.

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4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- 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 Anti-frost 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. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

- A. Grounding 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.
- B. 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.

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2. 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.
- C. 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. Test Wells: Install at least two test wells for each service unless otherwise indicated. Install at the ground rods electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. 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.
- E. 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 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.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 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.
- B. 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).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored 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 malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
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 in which used.
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units like MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 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 NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) 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, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in 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 (90 kg).
- 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS 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 meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid 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 (100 mm) 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 (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 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 (0.05 mm).
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings" for cleaning and touchup

painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install conduits as required, and as shown on the Plans. Materials employed shall be as shown on the Plans.

1.2 SUBMITTALS

- A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.
- B. If changes from the Plan are proposed, shop drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.
- C. Proposed routing of conduits buried under floor slabs-on-grade.
- D. Identify conduit by tag number of equipment served or by circuit schedule number.
- E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc.
- F. Proposed location and details of construction for openings in slabs and walls for raceway runs.
- G. Refer to Section 26000 "General Electrical Requirements" for further submittal requirements.

1.3 REFERENCES

- A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.
- B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.
- C. Underwriters Laboratories Inc. (UL):
 - 1. 1, Flexible Metal Conduit.
 - 2. 6, Rigid Metal Conduit.
 - 3. 360, Liquid-Tight Flexible Steel Conduit.
 - 4. 467, Grounding and Bonding Equipment.
 - 5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
 - 6. 651, Schedule 40 and 80 Rigid PVC Conduit.
 - 7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
 - 8. 884, Underfloor Raceways and Fittings.
 - 9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Exposed conduits in an unclassified or non-hazardous area shall be Galvanized Rigid Steel (GRS) unless specifically indicated otherwise on the Plans. Conduits in corrosive, hazardous, or damp areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All conduits concealed in block walls or steel framing shall be EMT with compression fittings unless otherwise indicated. Set screw type fittings in EMT conduit will not be accepted. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.
- B. Condulets type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors, damp, or wet locations shall be weather tight.
- C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.
- D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout. Conduit systems shall be watertight.
- E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.
- F. The conduits and fittings shall be supported per NEC requirements as a minimum.
- G. Sealing fittings shall be provided for classified areas per the NEC requirements in hazardous or corrosive areas. Fittings shall be poured after the final walk-thru unless otherwise directed in writing by the engineer.

2.2 GALVANIZED RIGID STEEL (GRS)

- A. Conduits and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.
- B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. Instead buried steel conduit shall be PVC coated.
- C. Myers Hubs

2.3 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

- A. PVC coated GRS conduit shall be installed where shown on the Plans or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.
- B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).
- C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.055-inch (55 mil).
- D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.
- E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.
- F. Conduit straps shall be PVC coated or stainless steel.
- G. PVC coated conduits and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.
- H. PVC coated flexible conduits shall be liquid and vapor-tight and manufactured in accordance with UL 360 standards.
- I. Myers Hubs

2.4 RIGID NONMETALLIC – PVC

- A. Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.
- B. Where conduit concrete encasement is indicated on the Plans, conduit supports shall be installed at five-foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

- C. Bell ends

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Liquid tight flexible metal conduit shall be liquid and vapor-tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquid tight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.
- B. For corrosive locations, liquid tight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors and PVC coated fittings shall be utilized.
- C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduits and connectors for 1 1/4 " and smaller shall be listed for grounding.
- D. For non-corrosive locations, connectors for liquid tight flexible conduit shall be hot-dipped galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.
- E. For systems utilized in corrosive locations, connectors shall be galvanized PVC coated.
- F. External Grounding Jumper

2.6 ELECTRICAL METALLIC TUBING (EMT)

- A. Per UL Standard for Electrical Metallic Tubing No. 797. Galvanized mild steel with interior coat of enamel.
- B. Fittings shall be steel set-screw type. Cast type, indenter type or compression steel fittings are not acceptable.
- C. Approved for plan specified locations only. Approved for conduits concealed in block walls and concealed in steel framed walls. Not approved for process areas where wash down or high humidity conditions exist.

2.7 ALUMINUM CONDUIT

- A. Aluminum conduit is approved for wet and corrosive areas only. Prior approval from the engineer must be obtained when substituting for PVC coated.
- B. Aluminum hardware and conduit shall be isolated from all dissimilar materials as appropriate.
 - 1. Isolation from dissimilar metals in channel or support by a single layer of scotch #33+ or approved equal.
 - 2. Isolation from concrete shall be by neoprene gaskets.
 - 3. Aluminum shall not be used for concrete penetrations.
- C. Aluminum conduit shall contain less than 0.4% copper.

2.8 STAINLESS STEEL CONDUIT

- A. Stainless Steel Conduit conduit is approved for all exposed conduit locations. Prior approval from the engineer must be obtained when substituting for PVC coated.
- B. Stainless Steel conduit and all fittings and support hardware shall be 316 SS.

2.9 CABLE TRAY SYSTEM

- A. Provide cable tray systems composed of straight sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1 - Ventilated Cable Tray.
 - 1. Provide cable trays and fittings shall constructed of materials suited for the area classification as noted below.
 - 2. Provide cable trays shall be of the ladder type with availability of 6, 9, and 12-inch spacing.
 - 3. Provide tray sizes with a 3, 4, 5, or 6-inch minimum usable load depth, as indicated on the drawings.
 - 4. Provide loading capacities that meet the NEMA weight classification with a safety factor of 1.5.
 - 5. In corrosive, damp, or Hazardous locations, provide cable trays manufactured of aluminum.
 - 6. In non-classified areas provide cable trays manufactured of Hot Dipped galvanized materials. All cuts and welds shall be touched up with cold galvanizing spray per the raceway specification.
 - 7. Separate power, control, signal and communications cables by grounded metallic dividers or run in separate trays.
 - 8. Manufacturer, or Approved Equal
 - a. Husky
 - b. B-Line
 - c. T.J. Cope

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conduit runs are schematic only and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.
- B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.
- C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the conduit type.

- D. Long Sweeps (conduits 3" and larger, 2/0 and larger wire, fiber) without approval from engineer
- E. Conduit runs in buildings and structures shall be concealed where possible except as specifically noted or accepted by the Engineer.
- F. Conduit runs shall not interfere with the proper and safe operation of equipment and shall not block or interfere with ingress or egress, including equipment removal hatches.
- G. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to vibrating equipment such as motors, fans, and transformers. The maximum length of flexible conduit shall be 3 feet, unless approved in writing by engineer. Flexible conduit shall not be used for electrician's convenience where rigid conduit could be used.
- H. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.
- I. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads.
- J. Bushings and lock nuts or hubs shall be used at conduit terminations. Conduit, bushings, locknuts, and enclosures shall be fastened to the conduit system prior to pulling wire. Splitting the bushings for installation will not be accepted. Hubs shall be used in all process areas outside of electrical rooms unless otherwise specified. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string. Splices shall be made in junction boxes only. Splices in conduit bodies will not be accepted.
- K. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the application.
- L. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.
- M. Housekeeping Pads
- N. Conduits routed into the tops of enclosures
- O. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used. Test results should be submitted to the engineer.

- P. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.
- Q. Provide trenching, backfill, and compaction for conduits installed underground.
- R. Raceways running parallel to hot water or steam piping shall maintain a distance of 6 inches from the piping.
- S. Raceways crossing steam or liquid filling piping shall cross above the piping.
- T. In slab conduits, shall be covered by a minimum of 2 inches of concrete.
- U. Conduits of the same duty (480V Power, 120V Power, 120V Controls and signals) shall have a minimum separation of 2 inches between conduits.
- V. Conduits and raceways carrying signal wiring shall have a minimum separation of 12 inches from 480V power raceways, 6 inches from 120V power raceways, and 4 inches from 120V control raceways.
- W. Raceways with 120V Control shall maintain a distance of 12 inches from 480V power raceways, 6 inches from 120V power raceways.
- X. Raceways with 120V power shall maintain a distance of 6 inches from 480V power raceways.

3.2 CABLE TRAYS

- A. Provide cable trays in strict accordance with the manufacturer's printed instructions.
- B. Allowable cable fill areas shall meet NEC Article 392 - Cable Trays requirements.
- C. Verify cable tray fills prior to installation based on cables and trays provided.
- D. Maintain continuous grounding of cable trays including bonding jumpers in accordance with the requirements of NEC Article 392.
- E. Install cable trays using hangers and supports on 8-foot centers, maximum.
- F. Install cable trays to walls as the primary method of support where possible.
- G. If support from the ceiling is the only alternative, use hangers and supports on 6-foot centers, maximum.
- H. Ensure that proper separation between duties as detailed in 3.1.

END OF SECTION 260533

SECTION 260534 – ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.2 RELATED SECTIONS

- A. For Raceways and Boxes for Electrical Systems see Section 260533 “Raceways and Boxes for Electrical Systems”.

1.3 SUBMITTALS

- A. Products shall be submitted in accordance with Section 260000 “General Electrical Requirements”, and elsewhere in the Contract Documents, prior to installation.

1.4 MANUFACTURERS

- A. Enclosures shall be manufactured by Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.1 STEEL

- A. Enclosures shall be fabricated from 14-gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.
- B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.
- C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

2.2 NEMA RATING

- A. Unless otherwise indicated on the Plans, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall

be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet or wash down areas.

- B. All enclosures used in classified areas shall be NEMA 7.
- C. In Wastewater facilities, all enclosures in process areas shall be NEMA 4X stainless steel. Enclosures in electrical rooms, meeting rooms, offices and shops shall be NEMA 12 unless otherwise specified.
- D. Areas not specified in Water Treatment, Wastewater, or other water related facilities shall be approved by the engineer for NEMA type prior to installation.

2.3 FIBERGLASS

- A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosures shall be installed as indicated on the Plans, and according to manufacturer's instructions.
- B. Enclosures shall be properly grounded and shall include ground straps connected to hinged doors and accessories.

END OF SECTION 260534

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
2. Handholes and boxes.
3. Manholes.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For accessories for handholes and boxes.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- B. Underground Plastic Utilities Duct: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- C. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 HANDHOLES AND BOXES

- A. Description: Comply with SCTE 77.
 - 1. Color: Gray or Green, depending on location.
 - 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC."

6. 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.
- B. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "General Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. 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 and Planting."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.2 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) 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 duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. 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.
 2. Concreting Sequence: Pour each run of envelope between terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations 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 (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 5. 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.
 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 6 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 24 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the 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.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "General Earthwork" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Section 312000 "General Earthwork."
5. After installing first tier of ducts, 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 ducts 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 as specified in Section 312000 "General Earthwork."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

UNDERGROUND DUCTS AND RACEWAYS

- a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test 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.

3.6 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 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.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

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, provide products by the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Stainless steel.
 - 5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Pre-sealed Systems.

2.4 GROUT

- A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

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.

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3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 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.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- 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 (25-mm) 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 (25-mm) 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 water stop 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 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Channel support systems.
 - 2. Restraint cables.
 - 3. Hanger rod stiffeners.
 - 4. Anchorage bushings and washers.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site class, building code and Design Spectral Response Acceleration as defined on the Contract Drawings.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division.
 6. Mason Industries.
 7. TOLCO Incorporated; a brand of NIBCO INC.
 8. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.
- F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.
- G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 2. Test at least four of each type and size of installed anchors and fasteners selected by Engineer.
 - 3. Test to 90 percent of rated proof load of device.
 - 4. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Table or list of equipment, panel and disconnect switch labels.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

NORTH VILLAGE SPECIAL SERVICE DISTRICT IDENTIFICATION FOR ELECTRICAL SYSTEMS

COYOTE LANE SEWER LIFT STATION

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- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags shall not be allowed.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.
- A. Write-On Tags shall not be allowed.

- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags shall not be allowed.

2.5 FLOOR MARKING TAPE

- A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
- C. Tag: Type I:
 - 1. Pigmented polyolefin, bright-colored, compounded for direct-burial service.
 - 2. Thickness: 4 mils.

3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

D. Tag: Type ID:

1. 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, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

- 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select 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 CONDUCTOR LABELING SCHEME

- A. All control and instrumentation conductors shall be labeled with a "To/From" labeling scheme. Each conductor label shall have two lines of text. The first line of text shall indicate the enclosure and terminal where the wire is to terminate on the other end. The second line of text shall indicate the enclosure and terminal where the wire is to terminate on this end. The following example illustrates the "To/From" labeling scheme:
 - 1. A wire is connected between a VFD and an LCP. The VFD equipment tag is VFD-100 and the LCP equipment tag is LCP-100. The connecting terminal at the VFD enclosure is terminal "5". The connecting terminal at the LCP is terminal "7". This wire would have the following labels:
 - a. The wire label at the VFD end:
Top Line: "LCP-100 : 7"
Bottom Line: "VFD-100 : 5"
 - b. The wire label at the LCP end:

Top Line: "VFD-100 : 5"
Bottom Line: "LCP-100 : 7"

3.2 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line 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.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.3 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Install labels at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. Colors for 208/120-V Circuits:

- 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
- b. Colors for 480/277-V Circuits:
- 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
- c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. 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.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 260573 – ELECTRICAL TESTING WITH COORDINATION STUDY

PART 1 – GENERAL

1.1 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE 1583 equations that are presented in NFPA 70E-2004, Annex D.
- C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract as well as all existing distribution equipment at the customer facility.
- D. The contractor shall perform electrical tests as described in Part 3 of this document.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American National Standards Institute (ANSI):
 - a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generator Stations and Substations.
 - b. C2, National Electric Safety Code.
 - c. C37.13, Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - d. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
 - e. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
 - f. C37.20.3, Metal-Enclosed Interrupter Switchgear.
 - g. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 - h. C62.33, Standard Test Specifications for Varistor Surge Protective Devices.
 - 2. American Society for Testing and Materials (ASTM):
 - a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
 - b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
 - d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - e. D971, Standard Test Method for Interfacial Tension of 0.1 against Water by the Ring Method.
 - f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.

- g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
 - i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
 - j. D1533, Standard Test Methods for Water in Insulating Liquids.
 - k. D1816, Standard Test Method for Dielectric Breakdown Voltage on Insulating Oils of Petroleum Origin Using VDE Electrodes.
 - l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method.
3. Institute of Electrical and Electronics Engineers (IEEE):
- a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
 - b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
 - c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
 - e. 118, Standard Test Code for Resistance Measurement.
 - f. 141, Recommended Practice for Electric Power Distribution and Coordination of Industrial Power Systems.
 - g. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - h. 399, Recommended Practice for Industrial and Commercial Power System Analysis
 - i. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
 - j. 1015, Recommended Practice for Apply Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 - k. 1584, Guide for Performing Arc-Flash Hazard Calculations
4. National Electrical Manufacturers Association (NEMA):
- a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - b. PB 2, Deadfront Distribution Switchboards.
 - c. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
- a. 70, National Electrical Code (NEC).

- b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.3 SUBMITTALS

- A. Analysis Studies Submittal: Submit prior to receiving final approval of the distribution equipment submittal and prior to release of equipment manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval may be obtained from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
 - 1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report and submitted to the Design Engineer
 - 2. The report shall include the following sections:
 - a. Executive Summary
 - b. Descriptions, purpose, basis and scope of the study
 - c. Tabulations of circuit breaker, fuse and other protective device ratings versus short circuit duties
 - d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trips unit settings, fuse selection
 - e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout\
 - f. Details of the incident energy and flash protection boundary calculations
 - g. Recommendations for system improvements, where needed
 - h. One-line diagram
 - 3. Arc flash labels shall be provided in hard copy only
 - 4. Sample copy of individual device test form.
 - 5. Sample copy of individual system test form.
- B. Administrative Submittals: Submit 30 days prior to performing inspections or tests:
 - 1. Schedule for performing inspection and tests.
 - 2. List of references to be used for each test.
 - 3. Sample copy of equipment and materials inspection form(s).
 - 4. Sample copy of individual device test form.
 - 5. Sample copy of individual system test form.
- C. Quality Control Submittals: Submit within 14 days after completion of test:
 - 1. Test or inspection reports and certificates for each electrical item tested.
- D. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data:
 - a. In accordance with references elsewhere in these specifications.
 - b. After test of inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.4 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
- C. The Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The Engineer shall submit references of at least ten actual short-circuit, protective device coordination and arc flash hazard analysis studies performed over the last five years.

1.5 QUALITY ASSURANCE

- A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
- B. Test instrument calibration shall be in accordance with NETA ATS.

1.6 SEQUENCING AND SCHEDULING

- A. Perform short-circuit, protective device coordination and arc flash hazard analysis studies prior to final approval of distribution equipment submittal
- B. Perform inspection and electrical tests after equipment has been installed.
- C. Perform tests with apparatus de-energized whenever feasible.
- D. Inspection and electrical tests on energized equipment are to be:
 - 1. Scheduled with OWNER prior to de-energization.
 - 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- E. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS

2.1 STUDIES

- A. Contractor is to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E Article 130.3 and Annex D.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis

studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

- B. Source combination may include present and future motors and generators
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. One-line diagram of the system being evaluated
 - 3. Source impedance data, including utility system and motor fault contribution characteristics
 - 4. Tabulations of calculated quantities
 - 5. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Unit substation primary and secondary terminals
 - 4. Low voltage switchgear
 - 5. Motor control centers
 - 6. Standby generators and automatic transfer switches
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
 - 3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs

- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 - 1. Electric utility's overcurrent protective device
 - 2. Medium voltage equipment overcurrent relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points, where applicable
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. The largest feeder circuit breaker in each motor control center and applicable panelboard
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208-volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum number of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must consider the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:
 - 1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 - 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
 - 3. Reactor data, including voltage rating, and impedance.

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4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X''_d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Equivalent impedance
 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Calculated asymmetrical fault currents
 - e. Equivalent impedance
 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. No AC Decrement (NACD) Ratio
 - e. Equivalent impedance
 - f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers
- C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
 - a. Current transformer ratio
 - b. Current setting
 - c. Time setting
 - d. Instantaneous setting
 - e. Recommendations on improved relaying systems, if applicable.
 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground)
 - b. Adjustable time-current characteristic
 - c. Adjustable instantaneous pickup
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations
1. Arcing fault magnitude
 2. Protective device clearing time
 3. Duration of arc
 4. Arc flash boundary
 5. Working distance
 6. Incident energy
 7. Hazard Risk Category
 8. Recommendations for arc flash energy reduction

PART 3 – EXECUTION

3.1 GENERAL

- A. Tests specified in this section are to be performed in accordance with the requirements elsewhere in these specifications.
- B. Coordination with local Utilities to obtain necessary information to perform the tests specified in this section is the responsibility of the Contractor. All costs incurred in obtaining required information shall be borne by the Contractor.
- B. Tests and inspection shall establish that:
 - 1. Electrical equipment is operational within industry and manufacturer's tolerances.
 - 2. All trip units are adjusted to avoid erroneous tripping of circuit breakers.
 - 2. Installation operates properly.
 - 3. Equipment is suitable for energization.
 - 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Adjust mechanisms and moving parts for free mechanical movement.
- E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- F. Verify nameplate data for conformance to Contract Documents.
- G. Realign equipment not properly aligned and correct un-levelness.
- H. Properly anchor electrical equipment found to be inadequately anchored.
- I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- K. Provide proper lubrication of applicable moving parts.
- L. Inform OWNER of working clearances not in accordance with NFPA 70.
- M. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.
- N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
 2. Vacuum and wipe clean enclosure interior.
 3. Remove corrosion found on metal surfaces.
 4. Repair or replace, as determined by OWNER, door and panel sections having dented surfaces.
 5. Repair or replace, as determined by OWNER, poor fitting doors and panel sections.
 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 7. Replace missing or damaged hardware.
 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.
 - b. If required due to extensive damage, as determined by OWNER, refinish the entire assembly.
- O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 COORDINATION STUDY FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.

3.3 ARC FLASH WARNING LABELS

- A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 1. Location designation
 2. Nominal voltage
 3. Flash protection boundary
 4. Hazard risk category
 5. Incident energy
 6. Working distance
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 1. For each 600, 480 and applicable 208-volt panelboard, one arc flash label shall be provided.
 2. For each motor control center, one arc flash label shall be provided.

3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

3.4 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 4 and Larger For:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends that do not conform with manufacturer's minimum allowable bending radius where applicable.
 - d. Color coding conformance with specifications.
 - e. Proper circuit identification.
2. Mechanical Connections For:
 - a. Proper lug type for conductor material.
 - b. Proper lug installation.
 - c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
 - a. Proper Shield grounding.
 - b. Proper terminations.
 - c. Proper circuit identification.
4. Control Cables For:
 - a. Proper termination.
 - b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
 - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
 - c. Insulation resistance values equal to, or greater than ohm values established by manufacturer.
 - d. Provide test reports to Engineer and Owner that show where test measurements were taken and the results
2. Contact Resistance Tests:
 - a. Contact resistance in micro-ohms across each switch blade and fuse holder.
 - b. Investigate deviation of 50% or more from adjacent poles or similar switches.

3.5 MOLDED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate frame size and trip setting with circuit breaker schedules or one-line diagram.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohm-meter for 480- and 600-volt circuit breakers.
 - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
 - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
 - d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
 - a. Contact resistance in micro-ohms across each pole.
 - b. Investigate deviation of 50% or more from adjacent poles and similar breakers.
3. Trip Coordination Study:
 - a. Provide coordination study of all new and existing equipment in the facility.
 - b. Adjust all circuit breaker settings per the coordination study.

3.6 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers for:
 - a. Cracked insulation.
 - b. Broken leads or defective wiring.
 - c. Proper connections
 - d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically that:
 - a. Grounding and shorting connections have good contact.
 - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.7 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.8 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

NORTH VILLAGE SPECIAL SERVICE DISTRICT ELECTRICAL TESTING WITH

COORDINATION STUDY

COYOTE LANE SEWER LIFT STATION

260573-12

1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled, and proper bonding was obtained.
6. Test ground system using 3-point fall of potential test equipment. Ground system must provide less than 5 ohms to ground resistance. Provide test reports to Engineer and Owner that show where test measurements were taken and the results. System must be tested at all ground rods, concrete encased electrodes, ground busses and service entrance locations.

3.9 AC INDUCTION MOTORS

- A. General: Inspection and testing limited to motors rated 10 hp and larger.
- B. Visual and Mechanical Inspection:
 1. Proper electrical and grounding connections.
 2. Shaft alignment.
 3. Blockage of ventilating air passageways.
 4. Operate Motor and Check for:
 - a. Excessive mechanical and electrical noise.
 - b. Overheating.
 - c. Correct rotation.
 - d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for proper operation.
 - e. Excessive vibration.
 5. Check operation of space heaters.
- C. Electrical Tests:
 1. Insulation Resistance Tests:
 - a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
 - 1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - 2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
 - b. Insulation resistance values equal to, or greater than, ohm values established by manufacturers.
 2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
 3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
 4. Measure running current and voltage and evaluate relative to load conditions and nameplate full-load amperes.

5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

3.10 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of draw out elements.
6. Integrity and contamination of us insulation system.
7. Check Door and Device Interlocking System By:
 - a. Closure attempt of device when door is in OFF or OPEN position.
 - b. Opening attempt of door when device is in ON or CLOSED position.
8. Check Nameplates for Proper Identification Of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbuttons.
 - c. Control switches.
 - d. Pilot lights.
 - e. Control relays.
 - f. Circuit breakers.
 - g. Indicating meters.
9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
 - a. Ohm value to be zero.
 - b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems by:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
 - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
 - b. Check for proper conductor lacing and bundling.
 - c. Check for proper conductor identification.
 - d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect Contactors For:
 - a. Correct mechanical operations.
 - b. Correct contact gap, wipe, alignment, and pressure.
 - c. Correct torque of all connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper size.

19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
 - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
 - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
 - d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
 - e. Test values to comply with NETA ATS, Table 10.2.
2. Current Injection through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:
 - a. Trip time in accordance with manufacturer's published data.
 - b. Investigate values more than 120 seconds.
3. Control Wiring Tests:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
 - c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
 - 1) Insulation resistance to be 1 megohm minimum.
4. Operational test by initiating control devices to affect proper operation.
5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

END OF SECTION 260753

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ACME Electric Corporation; Power Distribution Products Division.
 - 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 - 3. Controlled Power Company.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
 - 6. General Electric Company.
 - 7. Hammond Co.; Matra Electric, Inc.
 - 8. Magnetek Power Electronics Group.
 - 9. Micron Industries Corp.
 - 10. Myers Power Products, Inc.
 - 11. Siemens Energy & Automation, Inc.
 - 12. Sola/Hevi-Duty.
 - 13. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 1. Finish Color: Gray.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- J. 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.
- 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.
 2. Indicate value of K-factor on transformer nameplate.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
- M. Wall Brackets: Manufacturer's standard brackets.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated plastic or metal nameplate. Nameplates are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - c. 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.

3.3 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers electrical panelboards.

1.2 SUBMITTALS

- A. Products shall be submitted in accordance with Section 26 00 00, and the Contract Documents, prior to installation.
- B. Panel layout with alphanumeric designation, branch circuit breaker sizes and types, AIC rating, bus sizes, bus material and other characteristics.

1.3 QUALITY ASSURANCE

- A. NEMA PB-1, Panelboards
- B. NEC
- C. UL67, Panelboards

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Dead-front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the Plans. Buses shall be tin-plated copper. If shown on the drawings as 4 wire, neutral shall be 100% rated. Mounting and type of enclosures shall be as indicated on the Plans. Where not indicated, indoor enclosures shall be NEMA 12 and outdoor enclosures shall be NEMA 4. The minimum interrupting capacity of any device shall be 22 KAIC unless otherwise indicated on the Plans.
- B. All lighting panels shall have surge protection devices.
- C. Protective devices shall be replaceable without disturbing adjacent units and shall be of the bolt-on type. Snap in protective devices will not be accepted. Wire connectors shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the Plans, and a complete typed circuit schedule shall be furnished under a transparent cover and affixed to the inside of the panel access door. Phase busing shall be full height without reduction. Full size neutral and ground bars shall be included and shall have suitable lugs for each outgoing circuit requiring connection. Spaces for future protective devices provided in lighting panels shall be used for the maximum device that can be fitted into them.
- D. Panelboards shall be finished with a primer, rust resistant phosphate undercoat and two coats of oven baked enamel with finish ANSI grey. They shall be sized to provide a minimum of 4 inches of gutter space on all sides. Doors shall not uncover any live parts and shall be hinged

and have latches that require no tool to operate. Panelboard doors shall be lockable. Lock and two keys shall be furnished.

- E. Each panelboard shall have on the outside of the door, a limacoid nameplate with ¾-inch letters as specified elsewhere in these Contract Documents.
- F. Panelboards shall be as manufactured by Square D, General Electric, Eaton / Cutler Hammer, or equal.
- G. Panelboards shall be service entrance rated where required, and as shown on the Plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Panelboards shall be installed as indicated on the plans and according to manufacturer's instructions.
- B. Provide grounding per NEC, and Section 260526.
- C. Contractor shall verify all NEC clearance requirements prior to installation.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Appleton Electric Co. (Appleton).
2. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
3. Cooper Crouse-Hinds (Crouse-Hinds).
4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
5. Killark.
6. Leviton Mfg. Company Inc. (Leviton).
7. Pass & Seymour/Legrand (Pass & Seymour).

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 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 application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES FOR UNCLASSIFIED AREAS

- A. General Description
1. Convenience Receptacles, 125 V, 20 A
 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 3. Straight blade, grounding type, specification grade.
 4. Color: White unless Owner or Engineer specifies otherwise. Ivory for weather resistant receptacles. Yellow for corrosion resistant receptacles.
 5. Provide weather resistant receptacles for damp and wet areas (including all process areas or areas that may be sprayed down).
 6. Provide corrosion resistant receptacles for corrosive areas.
- B. Products: Subject to compliance with requirements, provide the following:
1. Dry, non-corrosive locations:
 - a. Hubbell; HBL5361 (single), HBL5362 (duplex).
 - b. Or Approved Equal.
 2. Damp or wet locations:
 - a. Hubbell; HBL5361WR (single), HBL5362WR (duplex).
 - b. Or Approved Equal.
 3. Corrosive locations:
 - a. Hubbell; HBL53CM61 (single), HBL53CM62 (duplex).
 - b. Or Approved Equal.

2.4 RECEPTACLES FOR CLASSIFIED AREAS

A. General Description

1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
2. Rated for 125 V, 20 A
3. Corrosion Resistant with malleable iron mounting box.
4. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.
5. Factory Sealed so that seal-offs are not required at the receptacle.
6. If receptacles are to have GFCI, this shall be achieved at the branch circuit overcurrent protective device (typically a lighting panel) in an unclassified space.

B. Products: Subject to compliance with requirements, provide the following:

1. Appleton U-Line Contender series.
2. Crouse-Hinds Arktite Series.
3. Or Approved Equal.

2.5 GFCI RECEPTACLES FOR UNCLASSIFIED AREAS

A. General Description:

1. Duplex GFCI Convenience Receptacles, 125 V, 20 A.
2. Straight blade, feed-through type.
3. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
5. Receptacles shall be tamper and weather resistant.

B. Products: Subject to compliance with requirements, provide the following:

1. Hubbell; GFR5362TR.
2. Or Approved Equal.

2.6 TOGGLE SWITCHES FOR UNCLASSIFIED AREAS

A. General Description:

1. Toggle Switches, 120/277 V, 20A
2. Comply with NEMA WD 1, UL 20, and FS W-S-896.
3. Toggle type, quiet action, specification grade with grounding terminal.
4. Back and side wired, silver alloy contacts.
5. Color: White unless Owner or Engineer specifies otherwise.
6. For corrosive or wet areas, provide a NEMA 4X watertight, dust-tight and corrosion resistant cover.

B. Switches:

1. Products: Subject to compliance with requirements, provide the following:

- a. Switches, 120/277 V, 20 A:
 - 1) Hubbell; HBL1221 (Single Pole); HBL1222 (Double Pole); HBL1223 (Three Way); HBL1224 (Four Way).
 - 2) Or Approved Equal.
- b. Illuminated Switches (illuminated when switch is "off"):
 - 1) Hubbell; HBL1221IL (Single Pole); HBL1223IL (Three Way).
 - 2) Or Approved Equal.
- c. Key-Operated Switches (with factory supplied key):
 - 1) Hubbell; HBL1221L
 - 2) Or Approved Equal.

2.7 TOGGLE SWITCHES FOR CLASSIFIED AREAS

A. General Description:

- 1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
- 2. Rated for 125 V, 20 A
- 3. Corrosion Resistant with malleable iron body and cover.
- 4. Factory Sealed so that seal-offs are not required at the receptacle.
- 5. Front operated handle with stainless steel shaft.
- 6. With grounding screw.

B. Products: Subject to compliance with requirements, provide the following:

- 1. Appleton Contender series.
- 2. Crouse-Hinds EDS Series.
- 3. Or Approved Equal.

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off." Load shall not exceed 80% of dimmer rating.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish except for stainless steel wall plates whose screws shall be stainless steel.
 - 2. Material for Finished Office Spaces: Smooth, high-impact thermoplastic, color to match device color.
 - 3. Material for Finished Spaces: Type 304 stainless steel.
 - 4. Material for Unfinished Spaces: Type 304 stainless steel.
 - 5. Material for Damp and corrosive Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
- C. Weatherproof, While-In-Use Covers: Where receptacles are required to be weatherproof and physically protected while in use or idle or where shown on the drawings, weatherproof, while-in-use covers shall be used in lieu of other covers. The cover shall have the following features:
 - 1. General Description:
 - a. Suitable style receptacle plate with a hinged cover.
 - b. Cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when the cover is closed.
 - c. Latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.
 - d. Sufficiently deep to allow full closure with plug(s) in use.
 - e. UL listed per UL Standard 514C and conform to NEC Article 410.57 paragraphs a and b, Article 110.3 and Article 110.11.
 - f. Body materials shall be of a flame resistant, self-extinguishing, UV inhibiting, impact resistant, polycarbonate resin. Materials must meet UL Standard 94 HF1.
 - g. Mounting screws shall be stainless steel and of sufficient length to properly secure the device and ensure seal to mounting surface.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Cooper; TP74 Series.
 - b. Or Approved Equal.

2.10 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: White unless Owner or Engineer specifies otherwise or otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to UPS or Emergency Power System: Red.
 - 3. TVSS Devices: Blue.

- B. Wall Plate Color: For plastic covers, match device color.

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 meet provisions of 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. Pig tailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Wherever possible, wiring devices shall be recess mounted with switches, receptacles and wall plates flush with the wall or surface.
 - 2. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 6. 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.
 - 7. Use a torque screwdriver when a torque is recommended or required by manufacturer.

8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. 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 down, and on horizontally mounted receptacles to the left.
2. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
3. Set switches and receptacles plumb and vertical to the floor.
4. Set recess-mounted switches and receptacles flush with face of walls.

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. Provide blank plates for empty boxes.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on the line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
4. Do not connect dimmers to loads in excess of 80% of the rating of the dimmer.

H. 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, multi-gang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience 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 262819 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers electrical disconnecting switches.

1.2 SUBMITTALS

- A. Products shall be submitted in accordance with Section 26000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Disconnect switches shall be heavy-duty safety switches with a quick-make, quick-break operating mechanism, with full cover interlock, and indicator handle.
- B. Where specified as fused disconnect switches, disconnects shall be furnished with fuses of the size indicated on the Plans. One set of spare fuses shall be furnished for each fused disconnect switch.
- C. Disconnect switches shall be NEMA type HD heavy duty construction, UL 98 listed.
- D. Enclosures shall be rated NEMA 12 for indoor use, and NEMA 3R for outdoor use, unless otherwise indicated on the Plans.
- E. Disconnect switch handle shall be pad lockable.
- F. Disconnect switches in damp, wet or corrosive areas as indicated on the Plans, shall be NEMA 4X, 304 stainless steel. All disconnect switches in wastewater applications shall be NEMA 4X unless otherwise noted on the plans.
- G. Disconnect switches located in hazardous locations shall be rated NEMA 7.
- G. Disconnect switches shall be as manufactured by Square D, Cutler-Hammer, Allen-Bradley, no equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Disconnect switches shall be installed as indicated on the Plans.
- B. Provide grounding per NEC, and Section 260526.

END OF SECTION 262819

SECTION 262923 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. See Section 26 24 19 "Motor-Control Centers" for VFDs installed in motor-control centers.

1.2 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. EMI: Electromagnetic interference.
- D. IGBT: Insulated-gate bipolar transistor.
- E. LAN: Local area network.
- F. LED: Light-emitting diode.
- G. MCP: Motor-circuit protector.
- H. NC: Normally closed.
- I. NO: Normally open.
- J. OCPD: Overcurrent protective device.
- K. PCC: Point of Common Coupling
- L. PID: Control action, proportional plus integral plus derivative.
- M. PWM: Pulse-width modulated.
- N. P&ID: Process & Instrumentation Diagram
- O. RFI: Radio-frequency interference.
- P. SCADA: Supervisory control and data acquisition.
- Q. TDD: Total Demand Distortion
- R. THD: Total Harmonic Distortion
- S. VFD: Variable-frequency drive.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFDs 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."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.

- B. System Harmonics Analysis: For each VFD and for the distribution system as a whole.
- C. Shop Drawings: For each VFD indicated. 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.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, communications, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD 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.
- B. Seismic Qualification Certificates: For VFDs, 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. Product certificates.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
- 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 NFPA 70.
- D. IEEE Compliance: Fabricate and test VFD according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs 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 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rockwell Automation, Inc.; Allen-Bradley PowerFlex 700 series drives.
 - 2. Schneider Electric, Inc.; Altivar Process 630 series drives.
 - 3. Eaton SVX/SPX9000 series drives.
- B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: Constant torque and variable torque.
- D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) 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 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.
- E. 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.
- F. Output Rating: Three-phase; 10 to 200 (60 as programmed default) Hz, programmable as voltage proportional to frequency throughout voltage range or with sensor-less vector control; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFD input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 5 percent.
 - 3. Input Frequency Tolerance: Plus, or minus 3 percent of VFD 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. Minimum Short-Circuit Current (Withstand) Rating: Equal to the rating of the gear feeding the drive. If not listed, 65 kA.
 7. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 122 deg F (50 deg C). This is specifically the requirement for the VFD unit itself and not the overall panel assembly. The overall assembly shall meet the requirements of 260000-1.4-A-8 which requires the overall assembly to operate at an ambient temperature of up to 104°F. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning. The majority of the MCC's for the project are located indoors in air-conditioned rooms which satisfies this requirement. VFD assemblies shall have appropriately designed ventilation and or air conditioning so as to protect the internal components and to keep internal panel temperatures below the internal components' rated temperatures.
 8. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C)
 9. Humidity Rating: Less than 95 percent (noncondensing).
 10. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
 11. Vibration Withstand: Comply with IEC 60068-2-6.
 12. Overload Capability: VFD system shall be rated for continuous operation at a minimum of 110% of motor load full load amps (FLA) times the motor service factor. Variable torque inverters shall be capable of delivering 110% of continuous rating for a minimum of 60 seconds. Constant torque inverters shall be capable of delivering 150% of continuous rating for a minimum of 60 seconds.
 13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 14. Speed Regulation: Plus, or minus 0.6 Hz.
 15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- H. Inverter Logic: Microprocessor based, VFD isolated from all power circuits.
- I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 100:1 speed range.
- J. 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.
- K. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 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. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable dead bands.
 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.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto-speed Search" feature is available and engaged.
- N. Bidirectional Auto-speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- O. 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.
- P. 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.
- Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.2 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
 2. Run.
 3. VFD Fault.
 4. All other lights as shown on the design drawings
- B. 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.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.
2. Total run time.
3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD 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).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

- a. Speed Reference: The VFD drive shall be capable of being controlled locally by a speed potentiometer or remotely by a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.
- b. A minimum of two programmable analog inputs shall be provided and would be typically used for PID process variable and set point. These signals shall be setup to accept a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.
- c. A minimum of six multifunction programmable digital inputs. The drive shall be expandable to handle additional digital inputs if required. The digital inputs shall be programmable to perform functions including, but not limited to:
 - 1) VFD Start/Stop Control (2 or 3 wire)
 - 2) Forward/Reverse/Stop Control
 - 3) Local/Remote. The VFD shall be programmable so that "Local" control may either be the keypad or by hard-wired start/stop and potentiometer. The VFD shall be programmable so that "Remote" control may either be hard-wired start/stop and 4- to 20mA speed control or via the communications network.
 - 4) VFD Interlock/Enable. This input when de-energized will not allow the VFD to run the motor under any circumstance.
 - 5) VFD External Fault. This input will trip the VFD and require a reset before allowing the motor to run again.
 - 6) Preset Frequencies. The VFD shall be programmable to run at pre-programmed frequencies with up to 6 different steps.

2. Output Signal Interface:

- a. A minimum of two programmable analog output signals 4- to 20-mA dc, which can be configured for any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (V dc).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set point frequency (Hz).
 - 7) Motor power (kW)
 - b. A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following (the drive shall be expandable to handle additional digital outputs if required):
 - 1) Motor running.
 - 2) VFD ready.
 - 3) Set point speed reached.
 - 4) Fault and warning indication (overtemperature or overcurrent).
 - 5) PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
 - 1. Number of Loops: One.
- G. SCADA Interface: Factory-installed hardware and software to enable the SCADA to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.
 - 1. Network Communications Ports: Ethernet
 - 2. SCADA Protocols for Network Communications: Ethernet/IP protocol accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: All new power distribution systems supplied shall be required to meet the requirements of IEEE 519-1992. Specifically, the system shall adhere to the TDD requirements of Table 10-3 of IEEE 519-1992. If the power distribution system is equipped with an Active Harmonic System, each VFD shall be equipped with a line reactor whose impedance is as recommended by the Active Harmonic System manufacturer (typically 3%). If no Active Harmonic System is part of the power distribution system, the following rules as a minimum shall define the input line conditioning for each VFD (unless further conditioning is required to meet the IEEE 519-1992 limits). With the Engineer's approval, the contractor may decide to supply an Active Harmonic System even if not shown on the drawings, with corresponding reactors and chokes (this would typically occur if it were more cost effective to meet IEEE 519 with a single system then multiple harmonic filters).

1. All VFD's sized for motors 50HP or larger shall be equipped with DC-link chokes.
 2. All VFD's sized for motors 40HP and less shall be equipped with 5%-line reactors unless specifically called out as otherwise on the drawings.
 3. All VFD's sized for 50HP to 200HP motors shall be equipped with passive harmonic filters with DC Link Chokes.
 4. All VFD's greater than 200HP shall be setup to have less than 5% THD for both voltage and current. This would typically require that the drive is setup with an 18-pulse front end or with an active harmonic filter. The VFD assembly shall accept a single 3-phase input and shall contain all of the harmonic mitigation equipment as part of the assembly.
- B. EMI/RFI Filtering: VFD's shall be CE marked and certify compliance with IEC 61800-3 for Category C2.

2.4 LOAD CONDITIONING

- A. Load Conditioning: For VFD driven loads with conductor lengths between 200 and 1,000 feet, output dV/dt filters shall be provided as part of the VFD assembly. It is strongly recommended that VFD motor leads not be longer than 500 feet and alternative VFD locations should be considered. If necessary, loads with conductor lengths greater than 1,000 feet shall have output sine wave filters shall be provided as part of the VFD assembly. Voltage drop considerations shall be considered when selecting the motor's nameplate voltage.

2.5 LINE AND LOAD CONDITIONING EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. MTE Corporation.
 2. Transcoil International (TCI).
 3. Or approved equal.
- B. Line Reactors: Reactors shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The reactor shall meet the following criteria:
1. The reactor shall be UL 508 listed.
 2. Continuous current rating: 100% RMS.
 3. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
 4. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
 5. All wiring shall be copper.
- C. Passive Harmonic Filters: Filters shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:
1. The filter shall be UL 508 listed.

2. The filter shall filter harmonics generated by the nonlinear VFD to satisfy the requirements of IEEE 519-1992 for individual and total harmonic voltage and current distortion at the input terminals of the filter.
 3. The THD of the current at the input terminals of the filter shall not exceed the limits defined in Table 10-3 of IEEE 519-1992.
 4. Full load efficiency: 97% or greater
 5. The filter shall not resonate with the power distribution system nor attract harmonics from other sources.
 6. The harmonic filter shall be a passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.
 7. The harmonic filter shall be equipped with a contactor that will connect the capacitor(s) only when the motor is running, avoiding nuisance VFD over-voltage tripping.
 8. All wiring shall be copper.
- D. dV/dt Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:
1. The filter shall be UL 508 listed.
 2. Maximum peak motor terminal voltage with 500 feet of cable: 15% of bus voltage.
 3. Maximum dV/dt: 200 Volts per microsecond.
 4. The dV/dt Filter shall reduce common mode voltages by a minimum of 40%.
 5. Continuous current rating: 100% RMS.
 6. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
 7. Allowed inverter switching frequencies: 1kHz to 8 kHz.
 8. Nominal inverter operating frequency: 60Hz; Minimum – 6 Hz; Maximum with de-rating: 120Hz.
 9. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
 10. Insertion loss: 3% of rated voltage maximum.
 11. All wiring shall be copper.
- E. Sine Wave Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:
1. The filter shall be UL 508 listed.
 2. Harmonic Voltage Distortion: 10% maximum
 3. Continuous current rating: 100% RMS.
 4. Intermittent current rating: 150% for 60 seconds.
 5. Allowed inverter switching frequencies: 2kHz to 8 kHz.
 6. Nominal inverter operating frequency: 60Hz; Minimum – 0 Hz; Maximum with de-rating: 90Hz.
 7. The Sine Wave Filter shall reduce common mode voltages by a minimum of 40%.
 8. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
 9. Insertion loss: 6% of rated voltage maximum.
 10. All wiring shall be copper.

2.6 BYPASS SYSTEMS

- A. Provide Bypass Systems only if indicated on the drawings.
- B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
- D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, NEMA-rated contactor.
 - 2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Contactor Configuration: Full-voltage (across-the-line) or reduced voltage soft-starter as shown on the drawings.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 - 6. Overload Relays: NEMA ICS 2.

2.7 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry, Clean and Non-corrosive Indoor Locations: Type 1.
 2. Outdoor or Corrosive Locations: Type 4X, stainless steel.
 3. Wash-Down Areas: Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - a. Push Buttons: Maintained and/or momentary as required.
 - b. Pilot Lights: LED types; colors as shown on P&ID's; push to test.
 - c. Selector Switches: Rotary type.
- B. Bypass contactor auxiliary contact(s) as required.
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. 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.
- E. Supplemental Analog Meters:
1. Elapsed time meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, 4X, and 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4, 4X, 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- H. Cooling Fan and Exhaust System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized: Supply fan, with non-corrosive intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

- I. Air Conditioning System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized; sized to maintain internal temperatures at or below 100°F.

2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFD while connected to its specified motor.
 - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- 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 each fusible-switch VFD.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify VFDs, 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 VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs 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 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- D. Tests and Inspections:
 1. Inspect VFD, wiring, components, connections, and equipment installation.
 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform each electrical test and visual and mechanical inspection 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

9. Perform voltage and current harmonic test with each VFD running at minimum and maximum speed. Submit test results for each VFD. Testing shall be witnessed by the Owner and the Engineer.

- E. VFDs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 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 switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- 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 Engineer before increasing settings.
- D. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. A minimum of 4 hours of training shall be provided. The training shall cover VFD theory of operation, features and functions available, normal operation, troubleshooting, and routine maintenance. The Contractor shall submit a syllabus for the training session for approval, within 3 weeks of conducting the class. Provide each attendee with a class syllabus detailing each topic to be discussed.

3.7 SPARE PARTS

- A. The following spare parts shall be supplied with each type, or frame size, of VFD:
 1. 3 sets of all replaceable fuses
 2. 3 spare air conditioner or fan filters

END OF DOCUMENT

SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. General: The CONTRACTOR shall provide a factory assembled standby diesel electric generator system complete and operable with digital electronic controls, in conformance to the Contract Documents.
- B. The provisions of this Section apply to standby diesel electric generators throughout the Contract Documents, except as indicated otherwise.
- C. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.
- D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator set.
- E. The CONTRACTOR shall be responsible for obtaining any required air quality permits on behalf of the OWNER, posting all public notices, and shall include all associated fees in their bid, listed as separate line items in the schedule of values. The generator vendor shall provide the Contractor with the documentation required for permitting, showing published proof of EPA certification on the engine specified and furnished herein.

1.2 CODES AND STANDARDS

- A. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:
 - 1. CSA C22.2, No. 14 – M91 Industrial Control Equipment
 - 2. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
 - 3. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
 - 4. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 - 5. FCC Part 15, Subpart B.
 - 6. IEC8528 part 4. Control Systems for Generator Sets.
 - 7. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
 - 8. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - 9. IEEE587 for voltage surge resistance.
 - 10. Mil Std 461D –1993. Military Standard, Electromagnetic Interference Characteristics.
 - 11. Mil Std 462D - 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.
 - 12. NEMA ICS10-1993 – AC Generator sets.

13. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702
 14. NFPA99 – Essential Electrical Systems for Health Care Facilities.
 15. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement
 16. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
 17. UL2200. The generator set shall be listed to UL2200 or submit to an independent third-party certification process to verify compliance as installed.
- B. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Kohler Power Systems; Generator Division.
 - b. Onan/Cummins Power Generation; Industrial Business Group.
 - c. Caterpillar; Engine Div.

1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 013000 - Contractor Submittals.
- B. Submit shop drawings containing actual dimensions, complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Shop drawings shall show proposed layout, anchoring, support and appurtenances, including clearances for maintenance and operations. Shop drawings shall show details of piping connections for fuel.
- C. Submit a complete list of equipment and material, including manufacturer's specifications, performance charts, catalog cuts and installation instructions, and recommended spare parts list. Submit data for each different item of equipment specified, including but not limited to engine, generator, switchgear, automatic transfer switch, vibration isolators, radiator, and other components. The data shall include a complete list of parts and source of supply.
- D. Submit performance test reports in booklet form showing all field tests, and adjustments performed to prove compliance with specified criteria.
- E. Operation and maintenance (O&M) manuals shall describe the step-by-step procedure required for system start-up, operation and routine maintenance. The O&M manuals shall include troubleshooting and repair guidelines, as well as wiring diagrams of the system as installed.
- F. Miscellaneous:

1. Dimensions, dry and wet weight.
 2. Manufacturer's kilowatts output curve and fuel consumption.
 3. Manufacturer's transient response data of the complete engine generator set upon 50%, 75%, and 100% block loads at 1.0 pf. Data shall include maximum voltage dips, maximum frequency dips, and recovery time periods.
 4. Engine altitude duration curve
 5. Generator motor starting curves showing the voltage dips versus starting KVA.
 6. Prototype test certifications showing all components comply with specifications.
- G. The following spare parts for the engine generator shall be supplied to the OWNER prior to acceptance of work: Two sets of oil filters, two sets of heavy-duty air filters, one dozen spare lamps, two fuses (for each control circuit).
1. Two set of oil filters.
 2. Two sets of heavy-duty air filters
 3. One dozen spare lamps
 4. Fuses (for each control circuit)

PART 2 -- PRODUCTS

2.1 ENGINE GENERATOR SET

A. Requirements

1. All materials, equipment, and parts comprising the units specified herein, shall be new and unused, and of the highest grade.
2. The engine, generator and all major items of auxiliary equipment shall be manufactured by manufacturers currently engaged in the production of such equipment. The unit shall be factory assembled and tested by the engine SUPPLIER and shipped to the job site by his authorized dealer having a parts and service facility in the area. The performance of the electric plant shall be certified by SUPPLIER as to the plant's full power rating, stability and voltage and frequency regulation, and field load tested at site.
3. The units offered under these Contract Documents shall be covered by the SUPPLIER's standard warranty, or guarantee, on new machines, and shall be a minimum of two years after the date of substantial completion.

B. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: 480 Volts AC, three phase, Three-wire, 60 hertz.
2. The generator set shall be rated at 70-kW, 87.5 kVA at 0.8 PF, after de-rating, based on site conditions of: Altitude 5650 ft. (1725 meters), ambient temperatures up to 122 degrees F (50 degrees C). The 70-kW sizing is an approximation, and it is the supplier's responsibility to properly size the generator based upon the following steps (include capacity for 20% additional future expansion):
 - a. Step 1 – Auxiliary Power – Estimated Load is 6 kW
 - b. Step 2 – Grinder (across the line starting) – 5 HP (Future)
 - c. Step 3 – Pump 1 (VFD driven) – 20 HP

d. Step 4 – Pump 2 (VFD driven) – 20 HP

3. The generator set rating shall be based on emergency/standby service.

C. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

D. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate more than 50 volts.

E. Connections

1. The generator set load connections shall be composed of tin-plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.2 ENGINE AND ENGINE EQUIPMENT

- A. The engine shall be natural gas, 4 cycle, radiator and fan cooled with 4 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
- B. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.
- C. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H₂O external static head. Radiator shall be sized based on a core temperature which is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment SUPPLIER. Rotating parts shall be guarded against accidental contact.
- D. Electric starter(s) capable of three complete cranking cycles without overheating.
- E. Positive displacement, mechanical, full pressure, lubrication oil pump.
- F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
- G. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
- H. Replaceable dry element air cleaner with restriction indicator.
- I. Flexible supply and return fuel lines.
- J. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
- K. Coolant heater.
 - 1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
 - 2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters

shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

3. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 4. The coolant heater(s) shall be sized as recommended by the engine SUPPLIER to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- L. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set SUPPLIER. Isolators shall include seismic restraints if required by site location.
- M. Starting and Control Batteries shall be calcium/lead antimony type, 24-volt DC, sized as recommended by the engine SUPPLIER, complete with battery cables and connectors.
- N. Provide an exhaust silencer for each engine of size and type as recommended by the generator set SUPPLIER and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
- O. A UL listed/CSA certified 10-amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
1. Loss of AC power - red light
 2. Low battery voltage - red light
 3. High battery voltage - red light
 4. Power ON - green light (no relay contact)
 5. Charger shall include an Analog DC voltmeter and ammeter, 12-hour equalize charge timer, and AC and DC fuses
- P. Provide a dual wall sub-base fuel storage tank with 24 hours of capacity at full load. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

2.3 GENERATOR

- A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase faults at approximately 300% of rated current for not more than 10 seconds.
- D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.4 GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated, and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following switches:
 - 1. MODE SELECT switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - 2. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.
 - 3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - 4. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- D. The generator set mounted control shall include the following AC Output Metering with the following features and functions:
 - 1. Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

2. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages and shall display all three phase voltages (line to neutral or line to line) simultaneously.
 3. Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.
- E. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel.
1. Low Oil Pressure (alarm).
 2. Low Oil Pressure (shutdown).
 3. Oil Pressure Sender Failure (alarm).
 4. Low Coolant Temperature (alarm).
 5. High Coolant Temperature (alarm).
 6. High Coolant Temperature (shutdown).
 7. Engine Temperature Sender Failure (alarm).
 8. Low Coolant Level (alarm or shutdown—selectable)
 9. Fail to Crank (shutdown)
 10. Fail to Start/Overcrank (shutdown)
 11. Overspeed (shutdown)
 12. Low DC Voltage (alarm)
 13. High DC Voltage (alarm)
 14. Weak Battery (alarm)
 15. Low Fuel-Daytank (alarm)
 16. High AC Voltage (shutdown)
 17. Low AC Voltage (shutdown)
 18. Under Frequency (shutdown)
 19. Over Current (warning)
 20. Over Current (shutdown)
 21. Short Circuit (shutdown)
 22. Overload (alarm)
 23. Emergency Stop (shutdown)
 24. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- F. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- G. The generator set mounted control shall include the following engine status monitoring:

1. Engine Oil Pressure (psi or kPA)
2. Engine Coolant Temperature (degrees F or C)
3. Engine Oil Temperature (degrees F or C)
4. Engine Speed (rpm)
5. Number of Hours of Operation (hours)
6. Number of Start Attempts
7. Battery Voltage (DC volts)
8. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

H. The generator set mounted control shall include the following engine control functions:

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which can discriminate between failed sender or wiring components, and an actual failure condition.
6. The generator system shall be provided with a communications system that allows for monitoring of the system via a Modbus TCP connection to the facility's control system. Provide a Modbus memory map that allows for monitoring of the generator's operational state, alarm conditions, output voltage, current & power and fuel level.

I. Alternator Control Functions:

1. The generator set shall include an automatic digital voltage regulation system that is matched, and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off.

Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall comply with the requirements of NFPA70 article 445.
 3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall comply with the requirements of NFPA70 article 445.
 4. Controls shall be provided to monitor the KW load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
 5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
 6. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- J. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

2.5 OUTDOOR WEATHER-PROTECTIVE HOUSING

- A. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
- B. The CONTRACTOR shall be responsible for appropriate sizing, location, and proper functioning as per the manufacturer's requirements.

- C. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color. All surfaces of all metal parts shall be primed and painted.
- D. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.
- E. Generator Sound Attenuation: The outdoor weather-protection housing shall also provide sound attenuation by allowing a maximum of 85 dBA at a distance of 23 feet from the generator enclosure.
- F. If the housing doors are elevated due to the fuel tank base, provide a portable platform system that is designed specifically for the generator assembly.

2.6 AUXILIARY POWER SYSTEM

- A. The generator shall be provided a 480V auxiliary feeder from the facility power distribution system. The generator assembly shall be designed to accept that feeder and provide disconnecting means, step down transformer (120/208V) and distribution panelboards as required for a complete and operable system.
- B. Provide lights and a light switch for the interior of the enclosure.
- C. Provide fans and heaters as necessary to prevent cold starts and overheating.
- D. Provide a 20A 120V convenience receptacle.
- E. Provide power to the battery charging system.

PART 3 -- EXECUTION

3.1 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.
- B. The generator set shall complete a time delay start period as programmed into the control.
- C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set and indicate "fail to crank" shutdown.
 2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".
 3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed and regulated

to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

- D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
- G. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

3.2 INSTALLATION

- A. Equipment shall be installed by the CONTRACTOR in accordance with Final Submittals and Contract Documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with SUPPLIER's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The CONTRACTOR shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment SUPPLIER.
- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with SUPPLIER's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the SUPPLIER.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- F. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 16.

3.3 FACTORY TESTING

- A. The generator set SUPPLIER shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided to the ENGINEER. Equipment supplied shall be fully tested at the factory for function and performance.
- B. Factory testing may be witnessed by the OWNER and ENGINEER. Costs for travel expenses will be the responsibility of the OWNER and ENGINEER. SUPPLIER is responsible to provide two weeks' notice for testing.

- C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.4 ON-SITE ACCEPTANCE

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the SUPPLIER, with required fuel supplied by Contractor. The ENGINEER shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

3.5 TRAINING

- A. The equipment SUPPLIER shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.6 SERVICE AND SUPPORT

- A. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The SUPPLIER shall maintain an inventory of critical replacement parts at the local service organization, and in-service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- B. The SUPPLIER shall maintain model and serial number records of each generator set provided for at least 20 years.

3.7 WARRANTY

- A. The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes automatic transfer switches rated 600 V and less.
- B. See Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.
- C. See Section 213213 "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.

1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. 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."
 - 2. Dimensioned 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.
- B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Caterpillar; Engine Div.
 - b. Emerson; ASCO Power Technologies, LP.
 - c. GE Zenith Controls.
 - d. Kohler Power Systems; Generator Division.
 - e. Onan/Cummins Power Generation; Industrial Business Group.
 - f. MTU Energy.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- J. Battery Charger: For generator starting batteries.
 - 1. Float type rated 10 A.
 - 2. Ammeter to display charging current.
 - 3. Fused ac inputs and dc outputs.
- K. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time

delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.

- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

- a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
- b. Push-button programming control with digital display of settings.
- c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 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."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 2. After installing equipment 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 Acceptance Testing Specification. Certify compliance with test parameters.
 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microohms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. 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.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264313 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - Class C Main Entrance Panel Surge Suppression Device

1.1 DESCRIPTION

- A. This Section describe the electrical and mechanical requirements for a high energy surge protective device. The specified surge protective device shall provide effective high energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category C3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category C3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:

1. 200,000 transient amps, per phase, of surge protection.
2. Protection modes: L-N, L-G, L-L, N-G.
3. Green, power present LED on front panel.
4. Remote alarms relay contact.

1.2 STANDARDS

- A. The specified device shall be designed, manufactured, tested and installed in compliance with:
1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 3. National Electrical Manufacturer Association (NEMA LS-1)
 4. National Fire Protection Association (NFPA 20, 70, 75 and 78)
 5. Underwriters Laboratories (UL 1449 third edition) listed
 6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516
- B. The system individual units shall be UL listed under UL 1449 Third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

1.3 ENTRANCE PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

- A. Environmental Requirements:
1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F
 2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F
 3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
 4. Operating Altitude: The system shall be capable of operation up to an altitude of 11,000 feet above sea level.
 5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.

6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated Table I below:

Table I

Voltage Description	Surge Current Per Phase	V _{peak} L-N	V _{peak} L-G	V _{peak} L-L	V _{peak} N-G	I _n	MCO V
120T 120/240 VAC 1ph, 3W + gnd	200kA	700V	700V	1200V	700V	20kA	150V
120Y 120/208 VAC 3ph, 4W + gnd, wye	200kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200 V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	200kA	N/A	1000V	1000V	N/A	20kA	320V
240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	200kA	700V 1200V* *	700V 1000V* *	1200V 1500V* *	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200 V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	200kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **Hi-leg

- Unit shall be installed in parallel with the protected equipment.
- Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.
- Protection per mode shall be: L-N 100kA, L-G 100kA, L-L 200kA, N-G 100kA.
- The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 150 kA. The surge life (8/20) shall be at least 10,000 occurrences at 6 kA. The surge protective capability shall be bi-directional and suppress both positive and negative impulses.
- The device shall be designed to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
- Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data

1.4 ENTRANCE PANEL PROTECTION SYSTEM COMPONENTS

- A. Diagnostics: Green solid-state LED indicators, per phase, shall be provided on the front cover to indicate protection status. Illuminated green LED's indicate full protection is

present at the protector, and an extinguished LED shall indicate a reduction in protection on that phase.

- B. NEMA 1, 12, 3R, 4, or 4X Enclosure as indicated on the Contract Drawings: Minimum 18-gauge steel. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

1.5 INSTALLATION AND MAINTENANCE

- A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.
- B. Units shall be installed as close as possible to the panel board to which it is connected. Lead length shall be less than 18 inches.
- C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

1.6 WARRANTY

- A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device from date of substantial completion.

PART 2 - Class B Branch Panel Surge Protective Device

2.1 DESCRIPTION

- A. These specifications describe the electrical and mechanical requirements for a high energy surge protective device. The specified surge protective device shall provide effective high energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category B3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category B3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:
 - 1. 150,000 transient amps, per phase, of surge protection.
 - 2. Protection modes: L-N, L-G, L-L, N-G.
 - 3. Green, power present LED, one per phase, on front panel.
 - 4. Remote alarm relay contacts, Form C.

2.2 STANDARDS

- A. The specified device shall be designed, manufactured, tested and installed in compliance with:
 - 1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 - 2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 - 3. National Electrical Manufacturer Association (NEMA LS-1)
 - 4. National Fire Protection Association (NFPA 20, 70, 75 and 78)

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5. Underwriters Laboratories (UL 1449 third edition) listed
6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

- B. The system individual units shall be UL listed under UL 1449 Third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

2.3 BRANCH PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 11,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated Table II below:

Table II

Voltage Description	Surge Current Per Phase	V _{peak} L-N	V _{peak} L-G	V _{peak} L-L	V _{peak} N-G	I _n	MCO V
120T 120/240 VAC 1ph, 3W + gnd	150kA	700V	700V	1200V	700V	20kA	150V
120Y 120/208 VAC 3ph, 4W + gnd, wye	150kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200 V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	150kA	N/A	1000V	1000V	N/A	20kA	320V
240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	150kA	700V 1200V* *	700V 1000V* *	1200V 1500V* *	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200 V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	150kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **High-Leg

2. Unit shall be installed in parallel with the protected equipment. No series connected protective elements shall be used.
3. Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.
4. Protection per mode shall be: L-N 75kA, L-G 75kA, L-L 150 kA, N-G 75 kA.
5. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 100 kA. The surge life (8/20) shall be at least 10,000 occurrences at 4 kA. The surge protection capability shall be bi-directional and suppress both positive and negative impulses.
6. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
7. Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data.

2.4 BRANCH PANEL PROTECTION SYSTEM COMPONENTS

- A. Diagnostics: One green solid-state LED indicators, per phase, shall be provided on the front cover to indicate protection status. Illuminated green LED's indicate full protection is present at the protector, and an extinguished LED shall indicate a reduction in protection on that phase.
- B. NEMA 1, 12, 3R, 4, or 4X Enclosure as indicated on drawings: Minimum 18gauge steel. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

2.5 INSTALLATION AND MAINTENANCE

- A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.
- B. Units shall be installed as close as possible to the panel board to which it is connected. Lead length shall be less than 18 inches.
- C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

2.6 WARRANTY

- A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device from date of substantial completion.

PART 3 - Class A Local Panel / Control Panel Surge Device

3.1 DESCRIPTION

- A. These specifications describe the electrical and mechanical requirements for a shunt installed AC power line surge device. The specified surge protective device shall provide effective energy surge diversion for application in ANSI/IEEE C62.41-1991 Location

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Category B3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category B3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:

1. 50,000 transient amps, per phase, of surge protection.
2. Protection modes: L-N, L-G, L-L, N-G
3. Green, power present LED, red, protection reduced LED on front panel.

3.2 STANDARDS

- A. The specified device shall be designed, manufactured, tested and installed in compliance with:
4. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 5. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 6. National Electrical Manufacturer Association (NEMA LS-1)
 7. National Fire Protection Association (NFPA 20, 70, 75 and 78)
 8. Underwriters Laboratories (UL 1449 third edition) listed
 9. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

The system individual units shall be UL listed under UL 1449 third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

3.3 LOCAL PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 10,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated in Table III below:

Table III

Voltage Description	Surge Current Per Phase	V _{peak} L-N	V _{peak} L-G	V _{peak} L-L	V _{peak} N-G	I _n	MCO V
120T 120/240 VAC 1ph, 3W + gnd	50kA	700V	700V	1200V	700V	20kA	150V

120Y 120/208 VAC 3ph, 4W + gnd, wye	50kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	50kA	N/A	1000V	1000V	N/A	20kA	320V
240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	50kA	700V 1200V* *	700V 1000V* *	1200V 1500V* *	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	50kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **High-Leg

2. Unit shall be installed in parallel with the protected equipment.
3. Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.
4. Protection per mode shall be: L-N 25 kA, L-G 25 kA, L-L 50 kA, N-G 25 kA.
5. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 50 kA, the surge life shall be at least 200 events at 6kA and 20,000 events at 2kA. The surge protection capability shall be bi-directional and suppress both positive and negative impulses.
6. The device shall be designed to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
7. Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data.

3.4 LOCAL PANEL PROTECTION SYSTEM COMPONENTS

- A. MOVs: The device shall be constructed of multiple 32 mm metal oxide varistors.
- B. Self-Diagnostics: Solid state red and green LED indicators shall be provided on the front cover to indicate AC power present at the device and protection status
- C. NEMA 1, 12, 3R, 4, or 4X enclosure as indicated on the drawings: Minimum 18-gauge steel provided with mounting flanges. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

3.5 INSTALLATION AND MAINTENANCE

- A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

- B. Units shall be installed as close as possible to the panelboard to which it is connected. Lead length shall be less than 18 inches.
- C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

3.6 WARRANTY

- A. Manufacturer to provide 10-year warranty to cover repair or the providing of a new device from date of substantial completion.

PART 4 - Class A Surge Suppression Device installed within Protected Equipment

4.1 DESCRIPTION

- A. These specifications describe the electrical and mechanical requirements for a series installed AC power line surge protective device. The specified surge protective device shall provide effective energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category A3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category A3 waveforms and amplitudes. UL 1449 recognized. The specified surge protective device shall provide:
 1. 10,000 transient amps of surge protection.
 2. L-N, L-G, H-G protected modes.
 3. Green protection present LED.
 4. EMI-RFI Filter.
 5. Low profile construction.

4.2 STANDARDS

- A. The specified device shall be designed, manufactured, tested and installed in compliance with:
 1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
 2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
 3. National Fire Protection Association (NFPA 20, 70, 75 and 78)
 4. Underwriters Laboratories (UL Second Edition 1449 Recognized)
 5. National Electrical Manufacturer Association (NEMA LS-1)
 6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516
- B. The system individual units shall be UL recognized under UL 1449 third Edition Standard for Surge Protective Device (SPD).

1.3 LOCAL EQUIPMENT ELECTRICAL REQUIREMENTS

- A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F.
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F.
3. Relative Humidity: Operating shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 13,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The power frequency range shall be 50-400 Hertz.

1.4 Electrical Requirements:

- A. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated in Table IV below.

Table IV

Voltage / Description	Joules 8/20us	Clamp @ 1mA	V Peak L - N
120 VAC 1phase, 2W + G	500	220V	392V
240 VAC 1phase, 2W + G	900	425V	760V

- B. Unit shall be installed in series or in parallel with the protected equipment.
- C. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 10 kA. The surge life (8/20us) shall be at least 10,000 occurrences at 500A. The surge protection capability shall be bi-directional and suppress both positive and negative impulses.
- D. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
- E. Equipment shall be as manufactured by MCG Electronics, Ditek, Transector or approved equal with supporting test data.
- F. The device shall contain a common mode noise filter with specifications as in Table V below:

Table V

Filter Attenuation (50 ohm)	Frequency
-20db	45 kHz
-30db	75 kHz
-40db	150 kHz
-50db	250 kHz
-60db	450 kHz

4.5 EQUIPMENT LEVEL PROTECTION SYSTEM COMPONENTS

- A. MOVs: The device shall be constructed of multiple metal oxide varistors.
- B. Self-Diagnostics: An illuminated green solid-state LED indicator shall be provided on the front cover to indicate protection is present at the device.

- C. Connection: Solderless Screw Terminals or hard-wired leads less than 12 inches.
- D. Enclosure: High-impact plastic.

4.6 INSTALLATION AND MAINTENANCE

- A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.
- B. Units shall be installed within the equipment to which it is connected.

4.7 WARRANTY

- A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device.

END OF SECTION 264313

SECTION 265000 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.

1.2 SCOPE OF WORK

- A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.3 QUALITY ASSURANCE

A. Reference Standards:

1. National Electrical Code (NEC)
2. UL Standard #57, Electric Lighting Fixtures
3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Location
4. UL Standard #1570, Fluorescent Lighting Fixtures
5. UL Standard #1571, Incandescent Lighting Fixtures
6. UL Standard #1572, High Intensity Discharge Lighting Fixtures
7. Illuminating Engineering Society (IES)
8. All applicable local lighting ordinances

B. Miscellaneous:

1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Plans.
2. Lighting fixtures and electrical components:
 - a. UL labeled, complete with lamps.
 - b. Rated for area classification as indicated.
 - 1) All lighting in classified areas are to be of the T3 temperature class unless otherwise indicated, refer to Table 500.8(B) of the NEC.
 - c. Lighting shall meet OSHA requirements.
3. On the Plans, the location of lighting fixtures is intended to be used as a guide.
 - a. Field conditions may affect actual locations.
 - b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
 - a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.4 SUBMITTALS

- A. The following shall be submitted to the Engineer for review:
 - 1. Acknowledgment that products submitted meet requirements of standards referenced.
 - 2. Manufacturer's technical information on products to be used including photometric performance curves for the fixture and ballast data.
 - 3. Acknowledgment that products submitted are UL listed.
 - 4. When general data sheets constitute part of the submittal, identify the products to be used on this project.
 - 5. Manufacturer's installation instructions.
 - 6. Identification of fixtures by Lighting Fixture Schedule.
 - 7. UL nameplate data (Voltage, wattage, etc.).
 - 8. Finishes, colors, and mounting type.
 - 9. Pole, fixture, and accessories.
 - 10. Pole wind loading.
- B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 013300 "Contractor Submittals" and Section 260000 "General Electrical Requirements."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lamps shall be manufactured by:
 - 1. General Electric
 - 2. North American/Phillips
 - 3. Sylvania
 - 4. Approved equal.
- B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Plans.
- C. Lighting ballasts shall be manufactured by:
 - 1. General Electric
 - 2. Advance
 - 3. Jefferson
 - 4. Universal
 - 5. Bodine
 - 6. Lithonia
 - 7. Approved equal
- D. Light poles shall be as indicated on the Plans. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, hand-hole, anchor base and bolt covers. Pole foundations shall be as indicated on the Plans.

2.2 MATERIALS

A. General:

1. Lamps:
 - a. See lighting fixture schedule on Plans for wattage, voltage and number required.
2. All Fixtures:
 - a. There shall be no live parts normally exposed to contact.
 - b. When intended for use in wet area:
 - 1) Mark fixtures "suitable for wet locations."
 - c. When intended for use in damp areas:
 - 1) Mark fixtures "suitable for damp locations" or "suitable for wet locations."
 - d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp-holder, or other electrical parts.
 - e. Gasket seals: Urethane foam
 - f. Diffusers: UV stabilized acrylic plastic
3. Underground wiring:
 - a. Provide all wiring runs with separate green grounding conductor.
 - b. Ground all pole bases.
4. Pole wiring from base to ballast:
 - a. No. 12 type XHHW.
 - b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuse-holder, Bussman "Limitron" type fuse, size rating 3-times load current.

B. Incandescent Lamps:

1. No incandescent lamps shall be allowed

C. Fluorescent Lamps:

1. Rapid start
2. Cool white (F32T8/41K-85CRI and F96T12/41K-70CRI/HO/ES)
3. Energy efficient or standard as noted on the lighting fixture schedule.

D. High-Pressure Sodium Lamps:

1. Bulb finish: Clear
2. Any burning position

E. Metal Halide Lamps:

1. Bulb finish: Clear
2. Any burning position

F. LED:

1. Lifespan: 50,000 hour
2. Minimum CRI: 85
3. Minimum Color Temperature: 4000K

- G. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

2.3 FIXTURES

A. Fluorescent Lighting Fixtures:

1. Ballast:
 - a. Rapid start, high power factor type
 - b. CBM/ETL certified
 - c. Sound rating A
 - d. Two internal automatic-resetting thermal switch devices for coil and capacitor
2. Internal wiring: AWM, TFN or THHN
3. Channel and end plates: 22 GA steel
4. Steel door frame and socket track: 20 GA steel
5. Channel cover: 24 GA steel
6. Emergency ballast:
 - a. Integral rechargeable nickel-cadmium battery, battery charger, and automatic transfer circuitry.
 - b. Charging indicator light.
 - c. Test Switch.
 - d. Provide a minimum of 900 lumen output for 90 minutes upon loss of normal power.
 - e. Mounted integral to the fixture.
 - f. UL 924 listed.
7. Provide fixtures with emergency ballasts with permanent caution labels warning that the fixture is fed from an un-switched source
 - a. Provide emergency ballast also with a similar caution label.

B. HID Lighting Fixtures:

1. Ballasts for high pressure sodium lighting fixtures:
 - a. Type: Regulating
 - b. Ballast design center variance: Maximum 5 percent from rated lamp wattage.
 - c. Lamp wattage regulation spread at the lamp voltage: Maximum 10 percent for +/- 10 percent line voltage variation.
 - d. Ballast primary current during starting not to exceed normal operating current.
 - e. Lamp current crest factor: Maximum 1.8 for +/-10 percent line voltage variation at any lamp voltage, from nominal through life.
 - f. Power factor shall not drop below 90 percent for +/-10 percent line voltage variations at any lamp voltage, from nominal through life.
 - g. Capacitor variance: Tolerance of +/-6 percent which will not cause more than a +/-8 percent variation in regulation throughout rated lamp life for nominal line voltage.
 - h. Capable of operation with an open circuit condition for a maximum of 6 months without significant loss of ballast or starting circuitry life.
2. Ballasts for metal halide/mercury vapor lighting fixtures:
 - a. Type: Auto-regulator
 - b. Voltage input range: +/-10 percent
 - c. Lamp regulation spread: 20 percent maximum
 - d. Power factor: 90 to 90 percent
 - e. Input voltage dip (4sec.): 40 to 50 percent

- f. Crest factor of lamp current: 1.6 to 2.0
- 3. Ballasts for exterior HID lamps:
 - a. UL approved
 - b. High power factor designed for -20 °F temperature starting
- 4. Fixtures for non-hazardous locations:
 - a. Type: Industrial low bay
 - b. Ballast housing: Diecast
 - c. Filter: Activated charcoal
 - d. Refractor: UV stabilized molded acrylic

C. LED Lighting Fixtures:

- 1. Heavy duty two piece, die cast aluminum housing.
- 2. Silicon gasketing for moisture protection
- 3. Polyester powder finish for impact, corrosion and UV resistance
- 4. Cast-in aluminum hinges for tool-less lens removal.
- 5. Thermal and shock resistant clear borosilicate glass refractor.
- 6. Field replaceable LED light engine and driver.

2.4 EMERGENCY FLUORESCENT POWER UNIT

- 1. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - a. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
- 2. Nightlight Connection: Operate one fluorescent lamp continuously.
- 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
- 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
- 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.

2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 1. Battery: Sealed, maintenance-free, lead-acid type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.7 MISCELLANEOUS ELECTRIC DEVICES

- A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:
 1. Cadmium sulfide photocell
 2. Aluminum weatherproof enclosure
 3. 30 amp rated contacts
 4. 120-volt AC power
 5. The Photoelectric control unit shall be Tork Model 2100, or equal.
- B. MOTION SENSORS shall meet the following requirements:
 1. 110° field of view, 60-foot range
 2. Adjustable time setting from 15 seconds to 15 minutes
 3. Operating temperature of -20 to + 130 °F.

4. Complete outdoor, weatherproof sensor with complete mounting hardware
5. UL listed
6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Install lamps in all luminaires.
- D. Replace all failed fluorescent, incandescent, metal halide, mercury vapor, high pressure sodium and LED lamps with new lamps prior to final acceptance by Owner.
- E. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless-steel chains and hooks. Each suspended fixture shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- G. Install with approved mounting hardware following manufacturer's recommendations.
- H. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports, and nonmetallic channel and angle supports.
 1. Do not support fixture from conduit system.
 2. Do not support fixture from outlet boxes.
- I. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Plans. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.
- J. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.
- K. Fixture mounting heights and locations indicated on the Plans are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.2 ADJUSTING AND CLEANING

- A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 265000

SECTION 40 61 13 – PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all Instrumentation and Control for Process Systems (hereafter referred to as I&C).

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents to provide a complete and coordinated project.

C. Complete I&C System

1. The requirements for the I&C System shall be the responsibility of a single company hereafter referred to as the Instrumentation Supplier (IS). The IS shall be responsible for all parts of this Section and Sub-Sections as well as all other related sections that may pertain to the I&C System.
2. The Contractor, through the IS and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of a complete I&C System. The IS shall provide all necessary coordination, material, and labor such that the entire system be complete and functional. This includes but is not limited to the proper operation and monitoring of electrical power systems, process systems, mechanical equipment, instrumentation, control panels, programmable controllers, communications/networking, and SCADA system.
3. The overall I&C system design is based upon non-certified information that has been furnished by various equipment manufacturers and vendors. It is the Contractor's responsibility to include in the bid and installation all labor and material to provide a complete system based upon actual information from equipment being supplied for the project. Any changes or additions due to non-certified manufacturer or vendor information shall be provided at no additional cost to the Owner.

1.2 REFERENCES

A. The installation and commissioning of the I&C System shall conform to all applicable codes, regulations, standards, and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. American National Standards Institute (ANSI)
3. American Petroleum Institute (API)

4. Federal Communications Commission (FCC)
5. Federal Occupational Safety and Health Act (OSHA)
6. International Society of Automation (ISA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. National Electric Code (NEC).
9. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
11. Underwriters Laboratories, Inc. (UL)

1.3 DEFINITIONS

- A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. FAT: Factory acceptance test.
3. HMI: Human machine interface.
4. I&C: Instrumentation and control for process systems
5. IS: Instrumentation supplier.
6. LAN: Local area network.
7. LCP: Local control panel.
8. NC: Normally closed.
9. NO: Normally open.
10. OIT: Operator interface terminal.
11. OSI: Owner's System Integrator.
12. PC: Personal computer.
13. PID: Control action, proportional plus integral plus derivative.
14. PLC: Programmable logic controller.
15. P&ID: Process and instrumentation diagram
16. RIO: Remote input/output
17. SCADA: Supervisory control and data acquisition.
18. SI: System Integrator.
19. UPS: Uninterruptible power supply.
20. VCP: Vendor control panel.
21. WAN: Wide area network

1.4 I&C SYSTEM REQUIREMENTS

- A. Work provided outside of Contractor's scope:
1. The following equipment is being furnished by the Owner:
 - a. SCADA Equipment
- B. The Work is to provide a complete and operational I&C System as described by the Contract Documents. This includes but is not limited to the following:
1. Before providing a bid as the IS, coordinate with all bidders such that all costs associated with a complete I&C System are accounted for. The Owner shall not be responsible for any additional costs for scope items that have been excluded from the bid because of not coordinating with all bidders.

2. The IS shall submit a statement of qualifications verifying that it meets the requirements of 406113.1.8. The IS must be approved by the Engineer before proceeding with the Work.
3. In order to provide a complete system, oversee and coordinate with all equipment and services being provided outside of Contractor's scope.
 - a. The Engineer is responsible to ensure that equipment being supplied by others related to the I&C System complies with the requirements of the Contract Documents
 - b. The Contractor and IS are responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.
4. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the IS's scope.
 - a. Inform all vendors and suppliers providing equipment related to the I&C System the requirements of Division 40.
 - b. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 40.
 - c. If a vendor or supplier is unable to meet the requirements of Division 40, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.
 - d. The Contractor and IS are responsible for coordinating with vendors and suppliers the FAT, installation, commissioning, calibration, and scheduling for the associated I&C equipment.
 - e. The IS is responsible to ensure that panel and loop drawings be supplied for vendor and subcontractor equipment. If the vendors and/or subcontractors are preparing the panel and/or loop drawings, they shall comply with the requirements of Division 40 and shall match those provided by the IS.
5. The IS shall conduct a Pre-Submittal Conference before producing any submittals. The conference should include all parties involved with the I&C System including the Engineer and Owner. The purpose of the conference shall be to review the project, make sure all parties understand their roles and responsibilities and to go over submittal requirements.
6. Prepare I&C System Submittals which includes the following:
 - a. Instrumentation hardware submittal (including TR20 forms).
 - b. Recommended spare parts submittal.
7. Following submittal approvals, do the following:
 - a. Procure all instrumentation hardware and accessories.
 - b. Procure hardware for and fabricate all control panels being provided.
 - c. Perform FAT's for all control panels being provided.
8. Programming and integration shall be supplied by the OSI. Oversee and coordinate the programming and integration with the OSI for a complete I&C System.
9. Oversee the installation of the I&C System.
10. Perform bench and field calibrations of instruments as required.

11. Oversee and document loop testing.
12. Oversee and document commissioning.
13. Maintain record drawings.
 - a. Maintain on the construction site a set of the Instrumentation Drawings that shall be continuously marked up during construction.
 - b. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
 - c. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.
14. Prepare O&M manuals.
 - a. Provide O&M manuals in accordance with Section 017823.
 - b. Prepare an O&M manual for each major process area or building. Each of these manuals shall be divided into the following categories:
 - 1) Table of Contents/Index.
 - 2) Process & Instrumentation Diagrams
 - 3) Control Panel Record Drawings, Bill of Materials and Design Data.
 - 4) Record Loop Drawings
 - c. Prepare O&M manuals that cover comprehensive information for the I&C System. These manuals shall include the following:
 - 1) Table of Contents/Index.
 - 2) Finalized Instrument Summary
 - 3) Finalized TR20 Instrument Forms
 - 4) Instrumentation Installation Details
 - 5) Instrument Operational Manuals
 - 6) Recommended Spare Parts List
15. Provide training.

1.5 ACTION SUBMITTALS

A. General

1. Submittals for Division 40 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
 - a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.
 - b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
 - c. Show product dimensions, construction, and installation details, wiring diagrams, and specifications.
 - d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.
2. Furnish submittal required by each Section within Division 40.
3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.

B. Instrumentation hardware submittal

1. Provide a comprehensive submittal that includes all instrumentation being supplied by the IS. Divide the submittal into the following:
 - a. Table of Contents/Index.
 - b. Instrument summary.
 - c. Instrument TR20 Forms.
 - d. Instrument Cut Sheets.
 - e. Instrument Installation Drawings.
2. Provide an instrument summary (sorted by tag number) that has the following information:
 - a. Tag number.
 - b. Make, model and description.
 - c. Associated process.
 - d. Location.
 - e. Calibrated range.
 - f. Referenced loop drawing number and P&ID.
 - g. Associated PLC.
3. Furnish TR20 instrumentation forms for each instrument using the forms outlined in ISA-TR20.00.01-2007. This requirement includes all instruments that are being installed as part of the project, whether they are Contractor, Owner and/or Vendor supplied. Show on each sheet who is the responsible party for supplying the instrument. The TR20 sheets should be provided electronically in Microsoft Word or Excel as well.
4. Provide instrument cut sheets for each instrument make and model being supplied for the project. Each cut sheet should have a list of instrument tag numbers that pertain to that cut sheet. The cut sheets should have enough information to verify that the instrument conforms to the Contract Drawings and Specifications.
5. Instrument installation drawings
 - a. Provide instrument installation drawings for each make and model of instrument being supplied.
 - b. Delineate what is being supplied by the IS and what is being supplied by other installers.
 - c. Show overall dimensions, mounting locations and elevations.
 - d. Show all cabling, conduit and piping locations.
 - e. Show the ambient conditions of the location where the instrument is being installed which includes ambient temperature and humidity extremes, whether the atmosphere is corrosive and the area classification.
 - f. Show mounting requirements, brackets, stands and anchoring.
 - g. Show means for sun protection where required.

C. Recommended Spare Parts Submittal

1. Submit a list of spare parts for all the equipment associated with the I&C System. The list of spare parts shall include list pricing for each item.
2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
3. Indicate whether the spare parts are being provided under this contract or not.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Calibration certificates.

- C. As-built TR20 forms.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.8 QUALITY ASSURANCE

- A. All equipment supplied for this project shall meet the requirements of the National Electric Code (NEC) and shall be listed by and bearing the label of the Underwriters' Laboratories (UL).
- B. The IS shall be a company that has been actively involved in the installation and commissioning of I&C Systems for a minimum period of five years.
- C. The IS shall have adequate facilities, manpower and technical expertise to perform the Work associated with the I&C System and as outlined by the Contract Documents.
- D. The IS shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The IS company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials provided under this Contract shall be new and free from defects.

2.2 MANUFACTURERS

- A. All equipment provided for the I&C System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.
- B. Instruments which utilize a common measurement principle (for example, float switches) shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.

2.3 OPERATING CONDITIONS

- A. The I&C System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
 - 1. Environment: Wastewater Treatment Plant.
 - 2. Temperature Extremes: -4°F to 104°F (Outdoors); 40°F to 104°F (Indoors).
 - 3. Relative Humidity: 20% to 90%, non-condensing.

- B. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided to maintain instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Instrumentation in hazardous areas shall be suitable for use in the hazardous or classified location in which it is to be installed.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.
- B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.
- C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.
- D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER'S SERVICES

- A. Manufacturer's services shall be furnished for the following equipment:
 - 1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
- B. The Contractor shall furnish the following manufacturer's services for the instrumentation listed below:
 - 1. Perform bench calibration.
 - 2. Oversee installation.
 - 3. Verify installation of installed instruments.
 - 4. Certify installation and reconfirm manufacturer's accuracy statement.

5. Oversee loop testing and pre-commissioning
6. Train the Owner's personnel.

3.3 INSTALLATION

- A. Instrumentation shall be installed per the Instrument Installation Drawings that have been submitted and approved and per the requirements of Division 40. This includes all instrumentation for the I&C System, regardless of who the supplier is. Instrumentation shall be mounted so that it is easily accessible and viewable and such that it does not restrict access to other equipment. Mount instrumentation to pipe stands or wall mounts if they are not directly mounted or if the Contract Drawings indicate otherwise.
- B. The I&C System indicated throughout the design are diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.
- C. The I&C System is integrally connected to electrical, mechanical, and structural systems. Coordinate with these other disciplines the installation of these related components. All conduit, cables and field wiring shall be as required by Division 26.
- D. Instruments, control panels and all other I&C System related equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.
- E. Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The Contractor shall provide certification of this Work prior to reinstallation of each instrument.
- F. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.
- G. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.
- H. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

- A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control

systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

- B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
 - 1. Descriptions of test methods to be performed during the FAT.
 - 2. FAT Schedule and Procedure
 - 3. FAT Checklists that allow for sign-off and comments for each test method and procedure.
- C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
 - 1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
 - 2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.
 - 3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
 - 4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
 - 5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.
- D. Control Loop Test Methods: To demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
 - 1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
 - 2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
 - 3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
 - 4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.
- E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.
- F. All changes and/or corrections made during the FAT shall be noted on the checklists.
- G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

- A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

- A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.
- C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations need adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.
- D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.
- E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.
- F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
 - 1. Date of calibration
 - 2. Project Name.
 - 3. Tag Number.
 - 4. Manufacturer, model and serial number.
 - 5. Calibration data including range, input, output and measurement at each calibration point.
 - 6. Space for comments.
 - 7. Space for sign-off by party performing calibration.
- G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

- A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
 - 1. All associated equipment, conduit and wire has been permanently installed, terminated, and inspected.
 - 2. All wiring has been properly pulled, terminated, and labeled.

3. Each wire has been tested with a point-to-point test.
 4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
 5. All instrumentation has been appropriately installed and calibrated.
 6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.
- B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
1. Loop Number and Description
 2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
 - a. Each power distribution circuit.
 - b. Each control circuit.
 - c. Each alarm circuit.
 - d. Each PLC input/output point.
 - e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
 - f. Each hard-wired and software interlock.
- C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.
- D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.
- E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.
- F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

- A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.
- B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system

with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

- C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.
- D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.
- E. Electronic control stations incorporating proportional, integral, or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

- A. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.
- B. As part of the Training Plan, submit a résumé for everyone to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.
- C. Each training session shall include a written agenda.
- D. The Contractor shall train the Owner's personnel on the maintenance, calibration and repair of instruments provided.
- E. Within 10 days after the completion of each session, the Contractor shall submit the following:

1. A list of Owner personnel who attended the training.
2. A copy of the training materials used during the session with notes, diagrams, and comments.

END OF SECTION 40 61 13

SECTION 40 61 21 – PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes in-factory and field-testing requirements.
- B. Related Sections
 - 1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents to provide a complete and coordinated project.
- C. Complete I&C System
 - 1. The requirements for the I&C System shall be the responsibility of a single company hereafter referred to as the Instrumentation Supplier (IS). The IS shall be responsible for all parts of this Section and Sub-Sections as well as all other related sections that may pertain to the I&C System.
 - 2. The Contractor, through the IS and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of a complete I&C System. The IS shall provide all necessary coordination, material, and labor such that the entire system be complete and functional. This includes but is not limited to the proper operation and monitoring of electrical power systems, process systems, mechanical equipment, instrumentation, control panels, programmable controllers, communications/networking, and SCADA system.
 - 3. The overall I&C system design is based upon non-certified information that has been furnished by various equipment manufacturers and vendors. It is the Contractor's responsibility to include in the bid and installation all labor and material to provide a complete system based upon actual information from equipment being supplied for the project. Any changes or additions due to non-certified manufacturer or vendor information shall be provided at no additional cost to the Owner.

1.2 SUBMITTALS

- A. In addition to the submittal requirements of Section 40 61 13, provide the following:
 - 1. Test Results:
 - a. Pass/fail status of all digital I/O.
 - b. Results of analog I/O testing.
 - 2. Miscellaneous:
 - a. Detailed step-by-step in-factory and field test procedure at least 6 weeks in advance of scheduled test date. Include sign-off sheets and punch list forms and description of configurations to be tested.

- b. Complete inventory of equipment to be tested at factory including make, model, and serial number. Label each piece of equipment.
 - c. Preventative maintenance schedule.
- 3. Submit in accordance with 01 33 00.

PART 2 - SERVICES

2.1 MANUFACTURER'S SERVICES

- A. Manufacturer's services shall be furnished for the following equipment:
 - 1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
 - 2. Radar Level Transmitters
 - 3. Process Gas Analyzers
- B. The Contractor shall furnish the following manufacturer's services for the instrumentation listed below:
 - 1. Perform bench calibration.
 - 2. Oversee installation.
 - 3. Verify installation of installed instruments.
 - 4. Certify installation and reconfirm manufacturer's accuracy statement.
 - 5. Oversee loop testing and pre-commissioning
 - 6. Train the Owner's personnel.

2.2 FACTORY ACCEPTANCE TESTING (FAT)

- A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.
- B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
 - 1. Descriptions of test methods to be performed during the FAT.
 - 2. FAT Schedule and Procedure
 - 3. FAT Checklists that allow for sign-off and comments for each test method and procedure.
- C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
 - 1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
 - 2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.

3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
 4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
 5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.
- D. Control Loop Test Methods: To demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
 2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
 3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
 4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.
- E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.
- F. All changes and/or corrections made during the FAT shall be noted on the checklists.
- G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

2.3 FIELD QUALITY CONTROL

- A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

2.4 CALIBRATION

- A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.
- C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations need adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

- D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.
- E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.
- F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
 - 1. Date of calibration
 - 2. Project Name.
 - 3. Tag Number.
 - 4. Manufacturer, model, and serial number.
 - 5. Calibration data including range, input, output, and measurement at each calibration point.
 - 6. Space for comments.
 - 7. Space for sign-off by party performing calibration.
- G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

2.5 LOOP TESTING

- A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
 - 1. All associated equipment, conduit and wire has been permanently installed, terminated, and inspected.
 - 2. All wiring has been properly pulled, terminated, and labeled.
 - 3. Each wire has been tested with a point-to-point test.
 - 4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
 - 5. All instrumentation has been appropriately installed and calibrated.
 - 6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.
- B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
 - 1. Loop Number and Description
 - 2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
 - a. Each power distribution circuit.
 - b. Each control circuit.
 - c. Each alarm circuit.
 - d. Each PLC input/output point.
 - e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
 - f. Each hard-wired and software interlock.

- C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.
- D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.
- E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.
- F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

2.6 COMMISSIONING

- A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.
- B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.
- D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient

stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

- E. Electronic control stations incorporating proportional, integral, or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

END OF SECTION 40 61 21

SECTION 40 61 26 – PROCESS CONTROL SYSTEMS TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Training requirements.
- B. Related Sections
 - 1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 DEFINITIONS

- A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):
 - 1. CTC: Communications termination cabinet.
 - 2. FAT: Factory acceptance test.
 - 3. HMI: Human machine interface.
 - 4. I&C: Instrumentation and control for process systems
 - 5. IS: Instrumentation supplier.
 - 6. LAN: Local area network.
 - 7. LCP: Local control panel.
 - 8. NC: Normally closed.
 - 9. NO: Normally open.
 - 10. OIT: Operator interface terminal.
 - 11. OSI: Owner's System Integrator.
 - 12. PC: Personal computer.
 - 13. PID: Control action, proportional plus integral plus derivative.
 - 14. PLC: Programmable logic controller.
 - 15. P&ID: Process and instrumentation diagram
 - 16. RIO: Remote input/output
 - 17. SCADA: Supervisory control and data acquisition.
 - 18. SI: System Integrator.
 - 19. UPS: Uninterruptible power supply.
 - 20. VCP: Vendor control panel.
 - 21. WAN: Wide area network

1.3 SUBMITTALS

- A. TRAINING

1. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.
2. As part of the Training Plan, submit a résumé for everyone to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.
3. Each training session shall include a written agenda.
4. The Contractor shall train the Owner's personnel on the maintenance, calibration and repair of instruments provided.
5. Within 10 days after the completion of each session, the Contractor shall submit the following:
 6. A list of Owner personnel who attended the training.
 7. A copy of the training materials used during the session with notes, diagrams and comments.

PART 2 - EXECUTION

2.1 MAINTENANCE TRAINING

- A. Cover following areas as a minimum:
 1. Testing programs which can isolate faults to functional area.
 2. Theory, logic flow, physical hardware awareness, and interface connections and assembly of each equipment item.
 3. Diagnostic procedures using special and general-purpose test equipment. Theory, testing, and troubleshooting procedures given for special test equipment.
 4. Operation of computers and peripherals.
 5. Programming routines and procedures to enable students to take advantage of on-line and standby equipment for maintenance and performance verification.
 6. Present short operator's course to ensure students understand operator functions and man/machine interfaces. Explain displays and printouts so students understand how information is derived, when it is presented incorrectly, and use of guidelines to differentiate between software and hardware problems.

2.2 INSTRUMENT TRAINING

- A. Cover following areas as a minimum:
 1. General principle of operation.
 2. Calibration schedule.
 3. Calibration procedure.
 4. Calibration equipment required (if needed).
 5. Recommended spare parts.
 6. Consumable part – recommended replacement schedule (e.g., Reagents, filters, probe tips) and procedure.
 7. General care and maintenance with special consideration to all instruments that may require cleaning such as pressure and level elements, etc.

2.3 HMI TRAINING

- A. HMI functionality.
- B. How key components work; shall include, but not be limited to:
 - 1. Entering of set points.
 - 2. Using alarm matrix.
 - 3. Acknowledging and clearing alarms.

END OF SECTION 40 61 26

SECTION 40 71 13 – MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Magnetic flow meters are used to provide continuous flow measurement of the process. The flow instrument consists of a transmitter and a flow element.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dimensional Drawings
 - 2. Materials of Construction
 - 3. Measurement Accuracy
 - 4. Range and range ability
 - 5. Enclosure Rating
 - 6. Classification Rating
- B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

- A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.
- B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.
- C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each process measurement system shall typically consist of a sensor and a transmitter. Where shown on the drawings, the transmitter may be utilized for multiple sensors. When a transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.
- B. Each transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.
 - 1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
 - a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
 - b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement
 - 2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
 - a. Hart Protocol
- C. Each transmitter shall be powered by 115VAC ($\pm 10\%$) at 60Hz unless specifically shown on the drawings as being powered by 24VDC ($\pm 15\%$). Each transmitter shall retain its programmable settings in non-volatile memory.
- D. Each sensor and corresponding transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the transmitter shall be protected from the sun such that direct sunlight will not shine on the display.
- E. All transmitters shall be waterproof and made from corrosion resistant materials.
- F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 FLOW PROCESS MEASUREMENT DEVICES

A. MAGNETIC FLOW METER

- 1. Materials

- a. All mounting hardware shall be 316 stainless-steel, the instrument enclosure and the spool mag shall be rated NEMA 4X, the flow sensor liner shall be hard rubber, and the electrode material shall be Hastelloy.
 - b. Spool size shall be as specified on the drawings.
 - c. All applications with flow element below grade where no de-watering means or in submersible applications shall provide the flow element as NEMA 6P (IP-68).
 - d. Transmitter shall be integral or remote to the flow element as shown on the P&ID's.
2. Design and fabrication
- a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate. The meter shall use a pulsed DC magnetic field excitation.
 - b. Provide flanged end connections per ANSI B16 rated for piping system operating and test conditions.
 - c. Operating pressure: 150 psi.
 - d. Operating temperature: 32-150°F.
 - e. Grounding requirements: per manufacturer requirements. Typically, inlet and outlet grounding rings of same material as electrode.
 - f. When the transmitter is remote to the flow element, provide cable between flow element and transmitter. Coordinate with the installer the length of the cable required. No splices in any way will be allowed.
 - g. Complete zero stability shall be inherent to the meter system. The system shall have a programmable low flow cutoff.
 - h. Empty pipe detection to prevent false measurement when pipe is empty or partially filled.
 - i. Forward and reverse flow measurement and totalization as well as net flow totalization.
 - j. 4-20mA DC isolated output into maximum 800 ohms. Signal shall be programmable to indicate forward and/or reverse flow.
 - k. Provide a dry contact output for flow direction indication.
 - l. Provide a programmable frequency output for flow totalization.
 - m. $\pm 0.5\%$ accuracy for flow rates above 1 fps.
3. Acceptable Manufacturers
- a. Siemens SITRANS F 5100W.
 - b. Endress+Hauser Promag W 400.

- c. Rosemount 8700.
- d. ABB WaterMaster.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.
- B. Install all transmitters five feet above floor level. Install in a location that is easily accessible and visible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

- A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.
- B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.
 - 2. Test the process measurement system for proper operation at low, mid, and high process conditions.
- B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

- A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 71 13

SECTION 40 72 43 – PRESSURE AND DIFFERENTIAL PRESSURE TYPE LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Pressure and differential pressure type level meters provide continuous level monitoring of the process. The pressure instrument consists of a transmitter and pressure measuring sensors.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dimensional Drawings
 - 2. Materials of Construction
 - 3. Measurement Accuracy
 - 4. Range and range ability
 - 5. Enclosure Rating
 - 6. Classification Rating
- B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

- A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.
- B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.
- C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each process measurement system shall typically consist of a sensor and a transmitter.
- B. Each transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.
 - 1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
 - a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
 - b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement
 - 2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
 - a. Hart Protocol
- C. Each transmitter shall be loop powered. Each transmitter shall retain its programmable settings in non-volatile memory.
- D. Each sensor and corresponding transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the transmitter shall be protected from the sun such that direct sunlight will not shine on the display.
- E. All transmitters shall be waterproof and made from corrosion resistant materials.
- F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 LEVEL PROCESS MEASUREMENT DEVICES

- A. SUBMERSIBLE LEVEL TRANSMITTERS
 - 1. The submersible level transmitter shall consist of a submersible transducer, electronic transmitter, support cable, and interconnecting cable with cable shield and vent tube for atmospheric reference. The vent tube shall be provided with a replaceable moisture barrier. The submersible transducer shall be the strain gauge type suitable for sensing pressure equivalent to the liquid level range indicated.

2. The transducer shall have 316 stainless steel process wetted parts and shall be provided with a waterproof interconnecting cable. The transducer shall be suspended by a corrosion resistant cable as recommended by the manufacturer. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic level transmitter shall be remote mounted and shall produce a 4 - 20 mA DC signal linearly proportional to the level range indicated and be capable of driving a load of 700 ohms.
3. The interconnecting cable shall have a pull strength of 200 pounds, be factory attached to the transducer, and shall be terminated in a NEMA 4X 316SS enclosure. The enclosure shall house the vent tube moisture barrier and local indication.
4. The measurement system shall be suitable for the area classification and operation over a temperature range of 32 to 122 degrees Fahrenheit with an accuracy of plus or minus 0.5 percent of span. The transmitter shall have a non-fouling, large diaphragm (greater than 2"). The diaphragm shall be protected by a spacer assembly that also allows the transducer to sit on the floor of the wet well.
5. For lengths greater than 20 feet the transducer shall have 1/2" threads and shall be suspended in the wet well by 1/2" stainless steel conduit.
6. Acceptable Manufacturers
 - a. TE KPSI model 750.
 - b. Mercoid model PBLT2.
 - c. Wika model LH-10 with LevelGuard attachment.
 - d. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.
- B. Install all transmitters five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

- A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.
- B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.
2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 72 43

SECTION 40 72 76 – LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Level switches provide point level measurement of the process.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dimensional Drawings
 - 2. Materials of Construction
 - 3. Measurement Accuracy
 - 4. Range and range ability
 - 5. Enclosure Rating
 - 6. Classification Rating
- B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

- A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.
- B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.
- C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as

required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each level switch system shall typically consist of a sensor and an output contact.
- B. Each level switch shall be equipped with means to transmit process measurement information to the plant SCADA system.
 - 1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
 - a. Form C dry type contacts rated for 10A up to 250VAC.
- C. Each level switch shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the level switch shall be protected from the sun such that direct sunlight will not shine on the display.
- D. All level switches shall be waterproof and made from corrosion resistant materials.
- E. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 LEVEL PROCESS MEASUREMENT DEVICES

A. FLOAT SWITCHES

- 1. Float switches shall consist of a mechanical switch, hermetically sealed in a plastic casing, freely suspended at the desired height from its own cable. When the liquid level reaches the float switch, the casing will tilt, and the mechanical switch will change state.
- 2. The casing shall be constructed of polypropylene with the sheathed cable extruding from the casing. The cable shall be three conductors, made specifically for underwater use and heavy flexing service.
- 3. The float switch shall have a 10A resistive rating up to 250VAC.
- 4. Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than one inch.
- 5. A NEMA 4X 316SS junction box shall be supplied for termination of the float cable(s) allowing for conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings.

6. Float switch cables shall be suspended in a manner that provides minimum strain to the cable and will not damage it. This is typically achieved with a stainless-steel cord support grip or strain relief grip as manufactured by Kellems. When support grips are used, a stainless-steel hook shall be installed for hanging the support. All screws, fasteners, boxes, and grips shall be 316SS. In no way are any steel or galvanized steel components allowed.
7. The float cable length shall be long enough for easily removing the float from the water for testing and long enough to reach its termination junction box.
8. If the float switch is to be installed in a classified area, an appropriate intrinsically safe barrier shall be utilized to guarantee the circuit may not abnormally create an ignition.
9. Manufacturers:
 - a. Flygt ENM-10.
 - b. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.2 CALIBRATION AND COMMISSIONING

- A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.
- B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.
 2. Test the process measurement system for proper operation at low, mid, and high process conditions.

- B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

- A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 72 76

SECTION 40 73 26 – GAUGE-PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Gauge pressure transmitters provide continuous pressure measurement of the process.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dimensional Drawings
 - 2. Materials of Construction
 - 3. Measurement Accuracy
 - 4. Range and range ability
 - 5. Enclosure Rating
 - 6. Classification Rating
- B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

- A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.
- B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.
- C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as

required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each process measurement system shall consist of a sensor and a transmitter. Where shown on the drawings, the /transmitter may be utilized for multiple sensors. When an /transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.
- B. Each transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.
 - 1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
 - a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
 - b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement
 - 2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
 - a. Hart Protocol
- C. Each transmitter shall be loop powered. Each /transmitter shall retain its programmable settings in non-volatile memory.
- D. Each sensor and corresponding transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the transmitter shall be protected from the sun such that direct sunlight will not shine on the display.
- E. All transmitters shall be waterproof and made from corrosion resistant materials.
- F. All sensors shall be rated for permanent submersion and shall be corrosion resistant.

2.2 PRESSURE PROCESS MEASUREMENT DEVICES

- A. General
 - 1. All inline pressure instruments shall be supplied with isolation ball valve and bleed needle valve for each measurement point. Valve materials shall be selected based upon the properties of the liquid or gas and the atmosphere.
 - 2. Unless otherwise indicated on the Contract Drawings, pressure process measurement devices shall measure process pressure relative to atmospheric pressure (gauge pressure).
 - 3. Pressure process measurement devices which are to measure differential pressure shall have the appropriate inlet and outlet ports and isolation and bleed valves for each port.

4. All pressure instrumentation shall be properly mounted, ideally in locations that are easily accessible and viewable. Supply all appropriate mounting poles, plates, and accessories such that each instrument is properly supported and mounted.

B. Pressure Transmitters

1. Electronic gauge pressure transmitters shall consist of a capsule assembly, bottom works, vent plug, drain plug, cover flange, ½" NPT process connector and connection, amplifier unit, integral indicator, terminal box with cover, block and bleed valves, and conduit connections.
2. Transmitter shall be rated NEMA 4X. For hazardous locations, it shall be installed with an appropriate intrinsically safe barrier to guarantee the circuit may not abnormally create an ignition.
3. Transmitter shall be of a two-wire, 24VDC loop powered, producing 4 to 20 mA output proportional to the calibrated range of the instrument, capable of driving a 600-ohm load.
4. Static pressure rating shall be a minimum of 500 psig. The maximum over range pressure limit shall be a minimum of 150% of the range. Span shall be adjustable over a minimum of 5:1 range.
5. The 4 to 20 mA signal shall be capable of being calibrated electronically. Output signal damping shall be provided as an internal adjustment. Equipment shall be suitable for an ambient operating range of -40°F to +176°F. The transmitter shall be equipped with the Hart protocol.
6. Accuracy, including linearity and repeatability, shall be a plus or minus 0.2 percent of span. Gauge pressure transmitters used for flow service shall include square root extraction to produce an output signal linearly proportional to flow. Wetted parts, including block and bleed valve parts, shall be constructed of 316 stainless steel.
7. Acceptable Manufacturers
 - a. Rosemount 2051.
 - b. Siemens SITRANS P320.
 - c. Endress + Hauser Cerabar PMC51.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.
- B. Install all transmitters five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

- A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 26 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.
- B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.
 - 2. Test the process measurement system for proper operation at low, mid, and high process conditions.
- B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

- A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 73 26

SECTION 40 76 00 – PROCESS GAS ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Process gas analyzers provide continuous gas measurement of the specified gases in the process or ambient environment.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Dimensional Drawings
 - 2. Materials of Construction
 - 3. Measurement Accuracy
 - 4. Range and range ability
 - 5. Enclosure Rating
 - 6. Classification Rating
 - 7. Power
 - 8. Output options
- B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

- A. All submittals as required in 40 61 13.

1.4 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.
- B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations, and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.
- C. All process lower and upper ranges to be coordinated with Engineer prior to instrument submittals being submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's and as required in section 26 05 00. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each process measurement system shall consist of a sensor and an analyzer. Where shown on the drawings, the analyzer may be utilized for multiple sensors. When an analyzer is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.
- B. Each analyzer shall be equipped with means to transmit process measurement information to the plant SCADA system.
 - 1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
 - a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
 - b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement
 - 2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
 - a. Hart Protocol
- C. Each analyzer shall be powered by 24VDC (+/- 15%) unless specifically shown on the drawings as 115VAC (+/- 10%). Each analyzer shall retain its programmable settings in non-volatile memory.
- D. Each sensor and corresponding analyzer shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer shall be protected from the sun such that direct sunlight will not shine on the display.
- E. All analyzers shall be waterproof and made from corrosion resistant materials.
- F. All sensors shall be rated for permanent submersion and shall be corrosion resistant.

2.2 GAS ANALYSIS PROCESS MEASUREMENT DEVICES

- A. Each gas sensor/analyzer shall be provided with a NEMA 4X rating for unclassified areas and NEMA 7 ratings (explosion-proof) for classified areas and specifically listed for Class 1, Division 1 groups B, C and D.
- B. All gas analyzers shall be 24VDC powered. Unless specifically indicated otherwise on the drawings, provide for each building with any gas analyzers a 24VDC power supply housed inside of a NEMA 4X enclosure.

- C. All analyzers shall have a 4-20mA output for each gas being detected capable of driving a 500-ohm loop load. All analyzers shall have programmable relays rated at 5A up to 230VAC for wiring to a PLC, Horn and/or beacon.
- D. Furnish and install a sampling pump module where required to draw an air sample into the analyzer sensor.
- E. Infrared type sensors shall be supplied when available for gases being detected.
- F. Provide maintenance and calibration equipment necessary to maintain and calibrate the gas analyzers for a period of three years.
- G. The following gas detection configurations shall be considered as standard unless shown otherwise on the drawings:
 - 1. Carbon Monoxide: 0-500 ppm
 - 2. Combustible Gas: 0-100% LEL
- H. The gas analyzers shall be furnished with a display that indicates the measured gas level.
- I. Acceptable Manufacturers:
 - 1. MSA Ultima X Series
 - 2. Det-tronics

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.
- B. Install all analyzers five feet above floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

- A. A manufacturer representative shall field calibrate the process measurement system as required by section 40 61 21 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.
- B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.
2. Test the process measurement system for proper operation at low, mid, and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration. These shall be submitted as part of the O&M manual as called for in section 40 61 13.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 40 61 26.

END OF SECTION 40 76 00