

**SPECIFICATIONS, SPECIAL PROVISIONS AND CONTRACT DOCUMENTS**

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT  
7420 NE 36TH ST, MIDWEST CITY, OK 73141**



**Matt Dukes, MAYOR**

**CITY COUNCIL MEMBERS**

**WARD 1 – Susan Eads**

**WARD 4 – Sean Reed**

**WARD 2 – Pat Byrne**

**WARD 5 – Sara Bana**

**WARD 3 – Rick Dawkins**

**WARD 6 – Rick Favors**

**Tim Lyon  
CITY MANAGER**

**Brandon Bundy  
DIRECTOR, ENG & CONST SERVICES**

**Sara Hancock  
CITY CLERK**

**Donald Maisch  
CITY ATTORNEY**

Prepared by:  
The City of Midwest City  
100 North Midwest Boulevard  
Midwest City, Oklahoma 73110  
(405) 739-1220

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THESE SPECIFICATIONS MUST BE READ AND CONSTRUED AS A WHOLE

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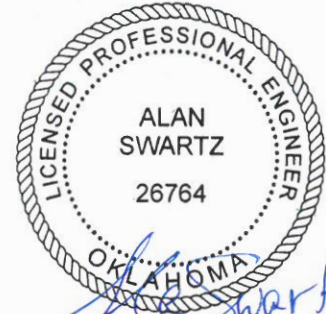
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**SPECIFICATIONS PREPARED BY:  
PLUMMER ASSOCIATES, INC**

**ALAN SWARTZ, P.E.**

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PB-1	Performance Bond
MB-1	Maintenance Bond
BID-1	Bid
DBF-1	Detailed Bid Form
NA-1	Non-Collusion Affidavit
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BB-1	Bid Bond
BRA-1	Business Relationship Affidavit
BA-1	Bid Affidavit
CC-1	Contractor Certification
SBQ-1	Statement of Bidder's Qualifications



*7/13/2023*

**DIVISION 01 – CONTRACT DOCUMENTS**

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01 11 00	Summary of Work
01 12 16	Construction of Sequence Items
01 29 00	Measurement and Payment
01 31 00	Project Administration
01 32 23	Survey and Layout Data
01 32 33	Project Documentation
01 32 39	Contractor Requirements
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**DIVISION 06 – WOODS, PLASTICS AND COMPOSITES**

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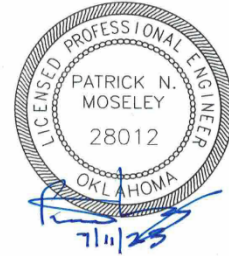
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**SPECIFICATIONS PREPARED BY:  
PLUMMER ASSOCIATES, INC.**

**PATRICK MOSELEY, P.E.**

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40 67 00	Control System Panels
40 71 00	Flow Measurement
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40 73 00	Pressure, Strain, and Force Measurement

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## NOTICE TO BIDDERS

Notice is given that the City of Midwest City will receive sealed bids in the Office of the City Clerk, Midwest City Municipal Center, 100 N. Midwest Boulevard, Midwest City, Oklahoma, until 2:00 p.m., on the **5th day of September 2023**, for:

### **NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

Any bids received after 2:00 p.m. on the above date will be returned unopened. Bids shall be made in accordance with the Notice to Bidders, Plans, Specifications and Bid Form, which are on file and available for public examination at the Office of the City Clerk in the Midwest City Municipal Center. Complete sets of general conditions, plans and specifications and other bidding documents may be obtained from the City of Midwest City, Department of Engineering & Construction Services, 100 N Midwest Blvd, Midwest City OK 73110.

Bids filed with the City Clerk shall be opened publicly and read aloud in the City Council Chambers at the time stated above or later. All bids shall be considered by the City Council prior to the contract being awarded. The Council may consider award of the project at or after 6:00 pm on **September 26, 2023**, to the lowest and best bidder meeting specifications. The Council may lay the same over to a subsequent meeting for comparison and computation.

Bids received more than ninety-six (96) hours, excluding Saturdays, Sundays, and holidays, before the time set for opening of bids, as well as bids received after the time set for opening of bids, will not be considered and will be returned unopened.

**The bidder shall use the City's Bid Form and Affidavits only** and all forms must be signed and notarized/attested. The bidder shall file the bid in a sealed envelope. Each envelope shall bear a legible notation thereon that it is a bid upon the project proposed. The bid shall be filed with the City Clerk in the City Clerk's office. All bids shall be typewritten or in ink.

**The following documents comprise the bid package. Incomplete bid packages may be rejected.**

- 1. Bid bond or cashier's check in the amount of five (5) percent of the total bid.**
- 2. Bid.**
- 3. Detailed Bid Form**
- 4. Certification of Pre-Bid Site Inspection (CSI).**
- 5. Statement of Bidder's Qualifications (SBQ).**
- 6. Business Relationships Affidavit (BRA).**
- 7. Bid Affidavit (BA).**
- 8. Non-Collusion Affidavit (NA).**
- 9. Addendum Acknowledgement(s)**
- 10. Contractor Certification**
- 11. References**


The bidder must attend a mandatory pre-bid conference at **2:00 p.m. on Tuesday, August 22, 2023** in the City Council Chambers, 100 N Midwest Blvd, Midwest City, Oklahoma. The bidder must inspect the project work site prior to submitting a bid. Refer to the Certification of Pre-Bid Site Inspection form, CSI-1, for additional information.

The specifications are complete as written. No oral representations made by any agent or employee of the City or its affiliate agencies shall be of any force or effect unless reduced to writing and submitted to all prospective bidders at least 24 hours in advance of the bid opening.

Any protest of the award of this proposed contract shall be in writing, shall specify the grounds for the protest in specific terms and shall be received by the City Council within three (3) business days after the award of the contract by the governing body. The governing body reserves the right to review all bids and make the award to the lowest and best bidder. All other provisions of the specifications shall also apply.

Additional information may be obtained from the City of Midwest City, Department of Engineering & Construction Services at (405) 739-1220.

The City Council of the City of Midwest City reserves the right to reject any or all bids.

  
\_\_\_\_\_  
SARA HANCOCK  
CITY CLERK

## GENERAL INFORMATION FOR BIDDERS

The City of Midwest City requires the execution and submittal of specific bid documents with each bid for a city, authority or grants project, and mandatory attendance at the prebid meeting. The following sections briefly outline the city's project bidding practices and procedures.

### BID PACKAGES

Each and every required bid document must be submitted with the bid and must be signed in ink by the person with the authority to so execute the document and must be properly attested to or witnessed. The documents required vary with the type and nature of the work and the required bid documents are always listed on the Notice to Bidders provided at the beginning of every specification book. The bid documents required for most projects are as follows:

- a. Bid bond or cashier's check in the amount of five (5) percent of the total bid
- b. Bid
- c. Detailed Bid Form
- d. Certification of Pre-Bid Site Inspection
- e. Statement of Bidder's Qualifications
- f. Business Relationships Affidavit
- g. Bid Affidavit
- h. Non-Collusion Affidavit
- i. Contractor Certification
- j. Addendum Acknowledgment(s)
- k. References

Grants projects and other projects involving federal funds require the additional documentation listed below:

- l. Affirmative action plan / preliminary work force needs statement
- m. Compliance statement
- n. Debarred lists certification

The following is a brief synopsis of the bid documents and is provided to assist you in completing the required forms.

#### 1. Bid Bond.

A Midwest City standard bid bond form **or** surety bid bond form **or** cashier's check in the amount of five (5) percent of the **total bid** is the required bid security in accordance with the provisions of the Public Competitive Bidding Act of 1974, as amended (61 Okla. Stat. 1991, § 107). A copy of the city standard bid bond form is provided as a part of the bid package and the form may be used in lieu of a bid bond provided by a surety company. The total bid amount that the bond or cashier's check is written for is the largest combination of the base bid plus the alternate bids.

The bid security is a pledge that the bidder will enter into a contract with the city on the terms stated in the bid and will furnish bonds covering the faithful performance of the contract and payment of all obligations. Should the bidder refuse to enter into such

contract or fail to furnish the required bonds, insurance certificates and other required documents, the bid security shall be forfeited to the city as liquidated damages.

The city bid bond form requires execution by a corporate officer representing the company submitting the bid and the bonding company. The surety company executing the bid bond must be authorized to transact business in the state of Oklahoma.

Federally funded projects have slightly different bonding requirements due to the involvement of federal funds. Surety companies providing bonds for federally funded projects, in addition to being authorized to transact business in Oklahoma, **must** appear on the current U.S. Treasury Department's Circular 570 as amended.

The city has the right to and does retain the bid securities of all bidders until either (a) the contract, bonds, and other required documents have been executed or submitted by the successful bidder or (b) the specified time to award bids has elapsed so that bids may be withdrawn in accordance with State law or (c) all bids have been rejected or (d) a bidder has been determined to be the successful bidder.

## 2. Bid

The bid is a complete and properly signed proposal, to do the work for the sums specified, submitted in accordance with the bid package documents and the contract documents. The "base bid" is the sum stated in the bid for which the bidder offers to perform the work described in the bid package documents as the base to which work may be added or from which work may be deleted for the sums stated in the alternate bid(s).

An "alternate bid (or alternate)" is an amount stated in the bid to be added to or deducted from the amount of the base bid if the corresponding change in the work, as described in the bid package documents, is accepted.

A "unit price" is an amount stated in the bid as a price per unit of measurement for materials, equipment or services, or a portion of the work as described in the bidding documents.

Bids must be submitted on the bid forms provided in the bid package at the prebid meeting or on photocopies of those forms. Bid forms are unique to each project and therefore forms other than those provided cannot and will not be accepted.

All blanks for unit prices with extensions must be completed and the bid must be totaled. The bid form must be executed by a corporate officer representing the company submitting the bid and the form must be attested to by another corporate representative or otherwise duly notarized. All blanks on the bid form must be filled in by typewriter or legibly printed in ink. Where indicated on the bid form, amounts shall be expressed in both words and figures and, in case of any discrepancy between the two, the amount written in words shall govern.

Unless otherwise provided for when unit prices are bid, partial payments and final claims will be based on actual quantities used. Any substantial change(s) in quantities required to complete the work requires a contract amendment which will be based on the unit prices bid.

Erasures and/or corrections must be initialed by the signer of the bid. A bid with erasures and/or corrections that are not initialed shall be considered to be invalid and incomplete.



An example of a properly completed bid form with sample correction is provided in the Appendix of these specifications.

3. Certification of Pre-Bid Site Inspection

The site inspection certification is a standard form that states that the bidder has visited the site and has become familiar with local conditions under which the work is to be performed. It indicates that the bidder has informed himself by independent research of the difficulties to be encountered and has personally judged the accessibility of the work and all attending circumstances affecting the cost of doing the work and of the time required for its completion.

The site inspection certification form requires execution by a corporate officer representing the company submitting the bid.

4. Statement of Bidder's Qualifications

The statement of bidder's qualifications is a standard form that provides the city with background information on the bidder. It is used solely as a matter of information to evaluate a prospective bidder's capacity to execute the contract requirements and to check references. Midwest City does not have a pre-qualification requirement or a contractor licensing requirement; therefore this document is required.

The statement of bidder's qualifications form requires execution by a corporate officer representing the company submitting the bid and must be duly notarized.

5. Business Relationships Affidavit.

6. Bid Affidavit.

7. Non-Collusion Affidavit.

The affidavit forms require execution by a corporate officer representing the company submitting the bid and must be duly notarized.

8. Contractor Certification.

The affidavit forms require execution by a corporate officer representing the company submitting the bid.

9. Addendum Acknowledgment(s)

Addenda are written or graphic instruments issued prior to the bid date which modify or interpret the bidding documents by additions, deletions, clarifications, or corrections.

The bidding documents represent all the information the city will provide. Interpretations and corrections of and/or changes to the bidding documents will be made only by addendum. Interpretations and/or changes made in any other manner will not be binding upon the city and bidders shall not rely upon them.

Addenda will be emailed only to those bidders who attended and signed the prebid meeting sign in sheet.

The following shall be considered proof that a bidder received an addendum:

- 1) Mailed addendum: The bidder's signature or bidder's representative's signature on the certified mail return receipt.
- 2) Hand delivered or picked-up addendum: The bidder's or bidder's representative's signature on the addendum received signature list.

It is the responsibility of the bidder to ascertain from the City Clerk's Office, within two working days prior to the bid date, whether the bidder has received all addenda.

An addendum acknowledgment sheet accompanies each and every addendum and must be signed by a corporate officer representing the company submitting the bid. All addendum acknowledgment sheets must be submitted with the bid in order for the bid to be considered.

10. References. Bidder shall supply the name, address, phone number, e-mail address and the name of an individual to contact for three references of organizations or entities the bidder has done the same or similar work.

## **PREBID MEETING**

The **mandatory** prebid meeting notice is included in the published **Notice to Bidders**, which is also provided at the beginning of every specification book. The notice specifies the date, time, and place for the meeting and the bidder must be represented at the meeting in order to be qualified to submit a bid for the project. The meeting is open to all prospective bidders and other interested parties. The consulting architect or consulting engineer and the city engineer or their designees will be present. The purpose of the meeting is to discuss the plans and specifications.

In compliance with the provisions of the Americans with Disabilities Act, a sign language interpreter or any other reasonable accommodation to attend and/or fully participate in the meeting will be provided at the prebid meeting upon twenty-four (24) hours notice to the city engineer.

## **ACCEPTANCE OF BID AND AWARD OF CONTRACT**

It is the intent of the city to award a contract to the lowest and best bidder meeting specifications provided that the bid submitted is in accordance with the requirements of the bidding documents and does not exceed the engineer's estimate or the funds available. The city has the right to waive immaterial defects or irregularities in bids received and to accept the bid which, in the city's judgment, is in its own best interest.

The city has the right to accept alternates in any order or combination, unless otherwise specifically provided in the bidding documents, and to determine the lowest and best bidder on the basis of the sum of the base bid and any alternates accepted.

The city reserves the right to offer the contract to the bidder deemed to be the next lowest and best bidder should the original bidder who is awarded the contract fail to execute and provide the contract and bonds or fail to provide the required certificates of insurance and/or any other required documents.

The city is providing a draft of a contract. It is anticipated that the winning bidder abide by the contract terms stated in the draft contract provided in these documents. It is anticipated that minimal negotiation for a contract will occur. Please read and make sure that you, as bidder, can meet all the terms and conditions contained in the draft contract before providing a bid. If a bidder submits a bid and then negotiations on the contract become protracted, the city has the right and authority to suspend negotiations, enter into negotiation with the next lowest and best bidder and execute upon the bid bond.

## **BONDS AND INSURANCE REQUIREMENTS**

As required by law, the bidder must furnish and execute in triplicate the required bonds in favor of the City of Midwest City. The bonds must be submitted on the standard bond forms provided in the bidding documents. The required bonds are:

a. Performance Bond

The performance bond guarantees the contractor's full and faithful execution of the work and performance of the contract and for the protection of the city and all property owners against any damage by reason of acts or omissions of the contractor or the improper execution of the work or the use of inferior materials.

b. Statutory Bond

The statutory bond guarantees that the contractor will make payment for all labor, materials and equipment used in the project.

c. Maintenance Bond

The maintenance bond guarantees the maintenance in good condition of the workmanship and materials for a specified period after completion and acceptance of the project by the City. The maintenance period is specified in the contract documents. The bond for the maintenance period is in an amount equal to one hundred percent (100%) of the contract amount.

The typical maintenance periods for City projects are as follows:

- 1 Year: All water, sanitary sewer, and drainage improvements installed separate from any road or bridge work.
- 2 Years: All buildings and park projects, all drainage improvement projects, except those portions of drainage improvement that are placed under streets which shall be bonded for five (5) years.
- 5 Years: All street and bridge projects including water, sanitary sewer, and drainage improvements installed directly in conjunction with those projects.

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**SECTION A**  
**SPECIAL PROVISIONS**

**1. GENERAL DESCRIPTION OF WORK**

The work to be performed under the provisions of these contract documents consists of the following: furnishing all materials, equipment, tools and plans; the performance of all necessary labor; and the complete construction of facilities, including all work appurtenant thereto.

**2. GENERAL CONDITIONS**

The General Conditions are general in scope and may refer to conditions not encountered on the work covered by this contract. Any provision of the General Conditions which pertains to a nonexistent condition and is not applicable to the work to be performed hereunder, or which conflicts with any provision of the Special Conditions, shall have no meaning in the contract and shall be disregarded.

**3. SPECIFICATIONS**

The specifications that govern the materials and equipment to be furnished and the work to be performed under this contract are listed in the following paragraphs. No attempt has been made in the specifications to segregate work that is to be performed by any trade or subcontract. Any segregation between trades or crafts will be solely a matter for agreement between the Contractor and his employees and his subcontractors.

All work performed under this contract shall be in full accordance with the laws and ordinances pertinent to such work. In case of any conflict wherein the methods or standards of installation or materials specified do not equal or exceed the requirements of the laws or ordinances, the laws or ordinances shall govern. All items required by the laws or ordinances but not specified or shown on the drawings shall be furnished without extra charge as shown or specified.

These Special Provisions are supplemental to the City of Midwest City Water Main and Sanitary Sewer Line Installation Specifications and Details, current edition, and Standard Specifications for Highway Construction, Oklahoma Department of Transportation (ODOT) 2019 edition, which govern all areas/types of construction and shall be considered as a part of these specifications and contract. Where the stipulations of the Special Provisions and the Midwest City specifications or plans are in conflict, the interpretation of the plans and specifications shall be made by the City.

The words "laws and ordinances" as used herein shall mean all local, state, or national codes, laws, ordinances, standards, rules or regulations of any nature which are in any way pertinent to, or regulatory over, the work covered by this contract.

**4. PERMITS AND FEES**

The Contractor shall secure all necessary permits or licenses to carry out this work and he shall pay all lawful fees, taxes, etc., in connection with the work.

## **5. EQUIVALENT MATERIALS AND EQUIPMENT**

Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function and quality desired, unless specifically stated otherwise. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer for the City of Midwest City (hereinafter "Engineer") to determine that the proposed products are equivalent to those named. Such items shall be submitted for approval by the procedure set forth in the SECTION B, General Conditions, 5. Shop Drawings. The words "or approved equal," although possibly not indicated after each proprietary specification, are implied as a result of the preceding statements in this paragraph.

## **6. WATER**

The City will furnish all water that is required in connection with the work to be done under this contract in the vicinity of the site without charge, provided:

- a. The Contractor shall procure such water in the location and in the manner designated by the Engineer.
- b. The Contractor, at his own expense, shall make authorized connections and provide means for delivering the water to the work site.
- c. The Contractor shall provide adequately against waste and needless use of such water.
- d. The City shall provide a backflow preventer valve for the Contractor's use. The backflow preventer must be used at all times.

## **7. LINES AND GRADES**

All work on lines, grades, and elevations shown on the plans shall be done. Basic horizontal and vertical control points will be established or designated by the Engineer. These points shall be used as datum for work under this contract. All additional survey, layout and measurement work shall be performed by the Contractor as a part of the work under this contract.

The Contractor shall provide an experienced instrument man, competent assistants, and such instruments, tools, stakes, and other materials as may be required to complete the survey, layout, and measurement work. In addition, the Contractor shall furnish (without charge) competent workers from his force and such tools, stakes and other materials as may be required by the Engineer in establishing or designating control points or in checking survey, layout, and measurement work performed by the Contractor.

All work done without being properly located may be ordered removed and replaced at the Contractor's expense.

## **8. CONNECTIONS TO EXISTING PIPELINES**

Where connections are made between new work and existing pipe lines, such connections shall be made in a thorough and workmanlike manner and to the satisfaction of the Engineer. Each connection with an existing water line shall be made at a time and under conditions as authorized by the City. Suitable facilities shall be provided for proper dewatering, drainage, and disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

**9. UNDERGROUND INSTALLATIONS AND STRUCTURES**

Pipelines and other existing underground installations and structures in the vicinity of the work to be done hereunder are indicated on the plans according to information available to the City. The City does not guarantee the accuracy of such information. The Contractor shall make every effort to locate all underground pipelines, conduits, and structures by contacting owners of underground utilities and by prospecting in advance of excavation or trenching. Should the Contractor encounter any utilities, whether shown or not on the plans, it will be his responsibility to protect the lines during construction. If there is any interference from alignment or elevation, it will be the responsibility of the Contractor to have these utilities relocated to permit construction to continue. Any delay or extra cost to the Contractor caused by pipelines or other underground structures or obstructions not shown on the plans or found in locations different from those indicated shall not constitute a claim by the Contractor for extra work, additional payment, or damages.

**10. FIELD CHECK OF EXISTING STRUCTURES**

It shall be the responsibility of the Contractor to check and verify all dimensions and elevations of existing structures, pipelines, equipment, or other existing items affected by or affecting the work under this contract. This shall be done prior to the start of construction or ordering of materials and equipment affected thereby.

The Contractor's attention is directed to the Advertisement for Bids which requires that each bidder visit the site of the work to familiarize himself with the arrangement and condition of existing construction. The drawings (in general) show only the details of existing construction that are to be connected to or that are to remain in place. The Contractor shall repair, to the Owner's satisfaction, any existing infrastructure, including private materials located in the City right of way, at no expense to the City and shall not constitute a claim by the Contractor for extra work, additional payment, or damages.

The Contractor shall be solely responsible for determining the extent and cost of all removal and salvage operations. Any delay or extra expense to the Contractor due to encountering construction, piping, or equipment not shown or in locations different from those indicated on the plans shall not constitute a claim by the Contractor for extra work, additional payment, or damages.

**11. DAMAGE TO EXISTING PROPERTY**

The Contractor will be held responsible for any damage to existing structures, work, materials, or equipment because of his operations; and shall repair or replace any damaged structures, work, materials, or equipment to the satisfaction of and at no additional cost to the City. The Contractor shall protect all existing structures and property (such as irrigation, landscaping, etc.) from such damage and shall provide bracing, shoring, or other work necessary for such protection.

**12. PUMPING AND DEWATERING OPERATION**

The Contractor shall furnish all equipment and materials for and shall construct and maintain as required temporary facilities for the care, handling, and removal of surface or seepage water or water from other sources which may be encountered during construction. The temporary facilities shall be removed after serving their purpose and the installation area dressed up so as not to interfere in any way with surface water drainage. Payment shall be considered incidental and shall be included in other items of work.

**13. SCHEDULE OF CONSTRUCTION OPERATIONS AND MAINTENANCE OF WATER SERVICE**

The Contractor shall submit to the Engineer for approval, before starting work, a schedule of his proposed construction operations. He will be required to consult with the Engineer and a schedule shall be established whereby the proposed construction operations may be executed with a minimum of interruption to the normal water service. The City will fully cooperate with the Contractor in arrangements for continuity of service and operation of valves and other control facilities. The schedule of operations shall indicate the sequence of the work, the time of starting and completion of each part, and the time for making connections to existing pipes, structures, or any other facilities.

The Contractor's attention is directed to the fact that water service cannot be shut down except for short periods of time, and then only with the City's specific approval and until the new portions of the work are placed in service.

If conditions beyond the control of the Contractor justify, and the City approves an extension of contract time, the Contractor shall revise the construction schedule in accordance with the approved extension. If operations fall behind the approved schedule to an extent that the completion of the work within the specified time appears doubtful, the City may require the Contractor to add to his plant, equipment, or construction forces, and/or increase the working hours.

Approval of the proposed construction schedule by the Engineer is necessary before the actual performance of the work, but it shall not relieve the Contractor of his obligations to cooperate with the City to the fullest extent.

**14. RIGHTS-OF-WAY**

The necessary rights-of-way and temporary and permanent easements have been provided by the City. The Contractor shall confine his construction operations to the immediate vicinity of the location shown on the plans and shall use care in placing construction tools, equipment, excavated materials, and construction materials and supplies, so as to cause the least possible damage to property and interference with traffic. The placing of such tools, equipment, and materials shall be subject to the approval of the Engineer.

Work Within Highway Rights-of-Way. All work performed and all operation of the Contractor, his employees, or his subcontractors, within the limits of highway rights-of-way, shall be in conformity with the requirements and be under the control (through the City) of the highway authority owning, or having jurisdiction over and control of, the right-of-way in each case.

The Contractor shall be solely responsible for obtaining (and shall pay all costs in connection with) any additional work area, storage sites, access to the site, or temporary right-of-way which may be required for proper completion of the work.

It shall be clearly understood that the responsibility for the protection and safekeeping of equipment and materials on or near the site will be entirely that of the Contractor and that no claim shall be made against the City by reason of any act of any employee or trespasser. It shall be further understood that, should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the Contractor owning or responsible for the stored materials or equipment shall immediately move same. No



materials or equipment may be placed upon the property of the City until the City has approved the location contemplated by the Contractor to be used for storage.

The Contractor will be required to return the right-of-way affected by construction operations to a same or better condition than it was prior to any work conducted.

**15. FENCES**

All existing fences which interfere with the construction operations shall be maintained by the Contractor until the completion of the work affected thereby. Temporary fences, with gates where necessary to constrain livestock or pets, shall be installed by the Contractor, unless written permission is obtained from the owner of the fence to leave the fence dismantled for an agreed period of time. Where fences must be maintained across the right-of-way, adequate gates shall be installed. The price for temporary fences and gates shall be included in the price bid for other items of work. Gates shall be kept closed and locked at all times when not in use. On completion of the work across any tract of land, the Contractor shall restore all fences to their original condition or better.

**16. PROTECTION AND MAINTENANCE OF PUBLIC AND PRIVATE PROPERTY**

The Contractor shall protect, shore, brace, support, and maintain all underground pipes, conduits, drains and other underground construction uncovered or otherwise affected by the construction work performed by him. All pavement, surfacing, driveway, curbs, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all shrubs in yards and parking, shall be restored to their original condition as determined and approved by the Engineer, within or outside the City's right-of-way. All replacements shall be made with new materials.

The Contractor shall not enter upon private property for any purpose without first obtaining permission and he shall be responsible for the preservation thereof and shall use every precaution necessary to prevent damage to all trees, fences, buildings, and other environments thereof and to all other public or private property along or adjacent to the work. The Contractor shall notify the proper representatives of any public service corporation, company or individual not less than twenty-four (24) hours in advance of any work which might damage or interfere with the operation of its or his property, along or adjacent to the work. The Contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect, or misconduct in the manner or method of executing the work or due to his non-execution of the work or at any time due to defective work or materials, and said responsibility shall not be released until the work shall have been completed and accepted. When and where any direct or indirect damage or injury is done to public or private property on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the non-execution thereof, on the part of the Contractor, he shall restore, at his expense, such property to a condition equal to or better than that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good for such damage or injury in an acceptable manner. The City's land shall be restored to a condition as good as or better than the original condition immediately after construction.

The Contractor shall either construct a temporary fence around all open excavations or backfill all open excavations on a daily basis to ensure that at no time are there any open excavations accessible.

No trees shall be removed outside of the permanent right-of-way except where authorized by the Engineer.

Additional information concerning areas where trees are specifically not to be removed are indicated on the plans.

The Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or workers to or from the work or any part or site thereof, whether by him or his subcontractors. The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property concerning its repair or replacement, or payment of costs incurred in connection with the damage.

The Contractor will be required to return the right-of-way affected by construction operations to a same or better condition than it was prior to any work conducted.

#### **17. MAINTENANCE OF TRAFFIC**

The Contractor shall conduct his work so as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, or walks (whether public or private) the Contractor shall, at his own expense, provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel. The Contractor shall give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when the Contractor has obtained permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point.

All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

#### **18. BARRICADES AND LIGHTS**

All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersection, public highway, or street on each side of the blocked section.

All open trenches and other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.

All barricades and obstructions shall be illuminated by means of warning lights from sunset to sunrise. Materials stored upon or alongside public streets and highways shall be so placed, and the work at all times shall be so conducted, as to cause the minimum obstruction and inconvenience to the traveling public.

All barricades, signs, lights, and/or other protective devices shall be installed and maintained in conformity with applicable statutory requirements and where within railroad and highway rights-of-way as required by the authority having jurisdiction thereover.

**19. SAFETY REQUIREMENTS**

The Contractor shall familiarize himself and his employees with the requirements of the U.S. Labor Department's Occupational Safety and Health Administration Standards. He shall work in accordance with these OSHA Standards and Regulations.

**20. ESTIMATED QUANTITIES**

All estimated quantities stipulated in the bid or other contract documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the work and (b) for the purpose of comparing the bids submitted for the work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. The Contractor agrees that he will make no claim for damages, anticipated profits, or other factors, which are due to any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts thereof.

**21. SPECIAL NOTICE**

The specifications are complete as written. No oral representations made by any agent or employee of the City or its affiliate agencies shall be of any force or effect unless reduced to writing and submitted to all prospective bidders at least 24 hours in advance of the Bid Opening.

Any protest of the award of this proposed contract to the lowest and best bidder by any bidder on the contract shall be in writing, shall specify the grounds for the protest in specific terms and shall be received by the City Clerk within three (3) business days after the award of the contract by the governing body. The governing body reserves the right to review all bids and make the award to the lowest and best bidder. All other provisions of these specifications shall also apply.

**22. APPLICABLE LAWS**

Contractor and its subcontractors shall at all times comply with all applicable laws (including, but not limited to, the Federal Mine Safety and Health Act of 1977 or the Occupational Safety and Health Act of 1970, whichever is applicable), ordinances, rules, regulations, codes and orders of the United States, any state, county or any executive or administrative agency thereof and any other governmental body having any jurisdiction over the work and with the safety rules and regulations of the City in force at the facility, and all materials, equipment, and work shall comply therewith. All required personal safety items, including gloves, protective headgear, steel-toed footwear, and safety glasses shall be provided by the Contractor at no expense to the City.

**23. CONTRACT TIME AND CITY OF MIDWEST CITY HOURS OF OPERATION**

The contract time allowed for completion of the project, as specified in the bid, expressed in consecutive calendar days, is that time estimated for completion and related testing of all items of work based on a five (5) day work week, eight (8) hours worked per day. Normal inclement weather days have been included in the contract time estimate.

The City of Midwest City engineering division observes working hours of 7:30 a.m. to 5:00 p.m., Monday through Friday and 7:30 a.m. to 4:00 p.m. on Saturday excluding designated

holidays. Work requiring inspection by the City must be performed during these observed times and days of operation. Inspection services can be provided outside the observed times and days of operation at the Contractor's request and with approval of the City. Requests must be submitted in writing to the City at least seventy-two (72) hours prior to the time requested, excluding weekends and holidays. The request must state day(s), time(s), and reason(s) in order for the City to evaluate the request and to schedule staff accordingly. Requests received less than 72 hours prior to the day(s) and time(s) of the requested inspections will not be honored.

**24. BASIS OF PAYMENT**

The prices bid shall be full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the work in accordance with the plans, these specifications, and the referenced City of Midwest City and Oklahoma Department of Transportation specifications.

**SECTION B**  
**GENERAL CONDITIONS**

**1 DEFINITIONS**

Wherever used in the CONTRACT DOCUMENTS, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

- a ADDENDA - Written or graphic instruments issued prior to the execution of the Contract which modify or interpret the CONTRACT DOCUMENTS, DRAWINGS and SPECIFICATIONS by additions, deletions, clarifications or corrections.
- b BID - The offer or proposal of the BIDDER submitted on the prescribed form setting forth the prices for the WORK to be performed.
- c BIDDER - Any person, firm or corporation submitting a BID for the work.
- d BONDS - Bid, Performance, Statutory and Maintenance Bonds and other instruments of security furnished by the CONTRACTOR and his surety in accordance with the CONTRACT DOCUMENTS.
- e CHANGE ORDER - A written order to the CONTRACTOR authorizing an addition, deletion or revision in the WORK within the general scope of the CONTRACT DOCUMENTS, or authorizing an adjustment in the CONTRACT PRICE or CONTRACT TIME.
- f CONTRACT DOCUMENTS - The CONTRACT, BONDS, NOTICE OF AWARD, NOTICE TO PROCEED, CHANGE ORDER, DRAWINGS, SPECIFICATIONS and ADDENDA.
- g CONTRACT PRICE - The total monies payable to the CONTRACTOR under the terms and conditions of the CONTRACT DOCUMENTS.
- h CONTRACT TIME - The number of calendar days stated in the CONTRACT DOCUMENTS for the completion of the WORK.
- i CONTRACTOR - The person, firm or corporation with whom the OWNER has executed the contract.
- j DRAWINGS - The part of the CONTRACT DOCUMENTS which show the characteristics and scope of the WORK to be performed and which have been prepared or approved by the ENGINEER.
- k ENGINEER - The City Engineer for the City of Midwest City.
- l FIELD ORDER - A written order effecting a change in the WORK, not involving an adjustment in the CONTRACT PRICE or an extension of the CONTRACT TIME, issued by the ENGINEER to the CONTRACTOR during construction.
- m NOTICE OF AWARD - The written notice of the acceptance of the BID from the OWNER to the successful BIDDER.
- n NOTICE TO PROCEED - Written communication issued by the OWNER to the CONTRACTOR authorizing him to proceed with the WORK and establishing the date of commencement of the WORK.
- o OWNER - City of Midwest City, a municipal corporation for whom the WORK is to be performed.

- p PROJECT - The undertaking to be performed as provided in the CONTRACT DOCUMENTS.
- q RESIDENT PROJECT REPRESENTATIVE - The authorized representative of the OWNER who is assigned to the PROJECT site or any part thereof.
- r SHOP DRAWINGS - All drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the CONTRACTOR, a SUBCONTRACTOR, manufacturer, supplier or distributor, which illustrate how specific portions of the WORK shall be fabricated or installed.
- s SPECIFICATIONS - A part of the CONTRACT DOCUMENTS consisting of written descriptions of a technical nature of materials, equipment construction systems, standards and workmanship.
- t SUBCONTRACTOR - An individual, firm or corporation having a direct contract with the CONTRACTOR or with any other SUBCONTRACTOR for the performance of a part of the WORK at the site.
- u SUBSTANTIAL COMPLETION - That date as certified by the ENGINEER when the construction of the PROJECT or a specified part thereof is sufficiently completed, in accordance with the CONTRACT DOCUMENTS, so that the PROJECT or specified part can be utilized for the purposes for which it was intended.
- v SUPPLEMENTAL GENERAL CONDITIONS - Modifications to General Conditions required by a federal agency for participation in the PROJECT and approved by the agency in writing prior to inclusion in the CONTRACT DOCUMENTS.
- w WORK - All labor necessary to produce the construction required by the CONTRACT DOCUMENTS, and all materials and equipment incorporated or to be incorporated in the PROJECT.
- x WRITTEN NOTICE - Any notice to any party of the contract relative to any part of the contract in writing and considered delivered and the service thereof completed when posted by certified or registered mail to the party at his last given address or delivered in person to said party or his authorized representative on the PROJECT.

## **2 ADDITIONAL INSTRUCTIONS AND DETAIL DRAWINGS**

- a The CONTRACTOR may be furnished additional instructions and detail drawings, by the ENGINEER, as necessary to carry out the WORK required by the CONTRACT DOCUMENTS.
- b The additional drawings and instructions thus supplied will become a part of the CONTRACT DOCUMENTS. The CONTRACTOR shall carry out the WORK in accordance with the additional detail drawings and instructions.

## **3 SCHEDULES, REPORTS AND RECORDS**

- a The CONTRACTOR shall submit to the OWNER such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the OWNER may request concerning WORK performed or to be performed.
- b Prior to the first partial payment estimate the CONTRACTOR shall submit schedules showing the order in which he proposes to carry on the WORK, including dates at which he will start the various parts of the WORK, estimated date of completion of each part and, as applicable:
  - (1) The dates at which special detail drawings will be required; and

- (2) Respective dates for submission of SHOP DRAWINGS, the beginning of manufacture, the testing and the installation of materials, supplies and equipment.
- c The CONTRACTOR shall also submit a schedule of payments that he anticipates he will earn during the course of the WORK.

#### **4 DRAWINGS AND SPECIFICATIONS**

- a The intent of the DRAWINGS and SPECIFICATIONS is that the CONTRACTOR shall furnish all labor, materials, tools, equipment and transportation necessary for the proper execution of the WORK in accordance with the CONTRACT DOCUMENTS and all incidental work necessary to complete the PROJECT in an acceptable manner, ready for use, occupancy or operation by the OWNER.
- b In case of conflict between the DRAWINGS and SPECIFICATIONS, the SPECIFICATIONS shall govern. Figure dimensions on DRAWINGS shall govern over scale dimensions and detailed DRAWINGS shall govern over general DRAWINGS.
- c Any discrepancies found between the DRAWINGS and SPECIFICATIONS and site conditions or any inconsistencies or ambiguities in the DRAWINGS or SPECIFICATIONS shall be immediately reported to the ENGINEER, in writing, who shall promptly correct such inconsistencies or ambiguities in writing. WORK done by the CONTRACTOR after his discovery of such discrepancies, inconsistencies or ambiguities shall be done at the CONTRACTOR's risk.

#### **5 SHOP DRAWINGS**

- a The CONTRACTOR shall provide SHOP DRAWINGS, in triplicate, as may be necessary for the prosecution of the WORK as required by the CONTRACT DOCUMENTS. The ENGINEER shall promptly review all SHOP DRAWINGS. The ENGINEER's approval of any SHOP DRAWING shall not release the CONTRACTOR from responsibility for deviations from the CONTRACT DOCUMENTS. The approval of any SHOP DRAWING which substantially deviates from the requirement of the CONTRACT DOCUMENTS shall be evidenced by a CHANGE ORDER.
- b When submitted for the ENGINEER's review, SHOP DRAWINGS shall bear the CONTRACTOR's certification that he has reviewed, checked and approved the SHOP DRAWINGS and that they are in conformance with the requirements of the CONTRACT DOCUMENTS.
- c Portions of the WORK requiring a SHOP DRAWING or sample submission shall not begin until the SHOP DRAWING, or submission, has been approved by the ENGINEER. A copy of each approved SHOP DRAWING and each approved sample shall be kept in good order by the CONTRACTOR at the site and shall be available to the ENGINEER.

#### **6 MATERIALS, SERVICES AND FACILITIES**

- a It is understood that, except as otherwise specifically stated in the CONTRACT DOCUMENTS, the CONTRACTOR shall provide any pay for all materials, labor, tools, equipment, water, light, power, transportation, supervision, temporary construction of any nature and all other services and facilities of any nature whatsoever necessary to execute, complete and deliver the WORK within the specified time.

- b Materials and equipment shall be so stored as to insure the preservation of their quality and fitness for the WORK. Stored materials and equipment to be incorporated in the WORK shall be located as to facilitate prompt inspection.
- c Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.
- d Materials, supplies and equipment shall be in accordance with samples submitted by the CONTRACTOR and approved by the ENGINEER.
- e Materials, supplies or equipment to be incorporated into the WORK shall not be purchased by the CONTRACTOR or the SUBCONTRACTOR subject to a chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller.

## **7 INSPECTION AND TESTING**

- a All materials and equipment used in the construction of the PROJECT shall be subject to adequate inspection and testing in accordance with generally accepted standards.
- b The CONTRACTOR shall provide at his expense the necessary testing and inspection services required by the CONTRACT DOCUMENTS, unless otherwise provided.
- c The OWNER shall provide all other inspection and testing services not required by the CONTRACT DOCUMENTS.
- d If the CONTRACT DOCUMENTS, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any WORK to specifically be inspected, tested or approved by someone other than the CONTRACTOR, the CONTRACTOR will give the ENGINEER timely notice of readiness. The CONTRACTOR will then furnish the ENGINEER the required certificates of inspection, testing or approval.
- e Neither observations by the ENGINEER nor inspections, tests or approvals by persons other than the CONTRACTOR shall relieve the CONTRACTOR from his obligations to perform the WORK in accordance with the requirements of the CONTRACT DOCUMENTS.
- f The ENGINEER and his representatives will at all times have access to the WORK. In addition, authorized representatives and agents of any participating federal or state agency shall be permitted to inspect all work, materials, payrolls, records of personnel, invoices of materials and other relevant data and records. The CONTRACTOR will provide proper facilities for such access and observation of the WORK and also for any inspection or testing thereof.
- g If any WORK is covered contrary to the written request of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for his observation and replaced at the CONTRACTOR's expense.
- h If any WORK has been covered that the ENGINEER has not specifically requested to observe prior to its being covered, or if the ENGINEER considers it necessary or advisable that covered WORK be inspected or tested by others, the CONTRACTOR at the ENGINEER's request will uncover, expose or otherwise make available for observation, inspection or testing, as the ENGINEER may require, that portion of the WORK in question, furnishing all necessary labor, materials, tools and equipment. If it is found that such WORK is defective, the CONTRACTOR will bear all the expense of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such WORK is not found to be defective, the CONTRACTOR will be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to such uncovering, exposure, observation,



inspection, testing and reconstruction, and an appropriate CHANGE ORDER shall be issued as the term CHANGE ORDER is defined in Section B, General Conditions, (1)(e).

## **8 SUBSTITUTIONS**

- a When a material, article or piece of equipment is identified on the DRAWINGS or SPECIFICATIONS by reference to brand name or catalogue number, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function shall be considered. The CONTRACTOR may recommend the substitution of a material, article or piece of equipment of equal substance and function for those referred to in the CONTRACT DOCUMENTS by reference to brand name or catalogue number and if, in the opinion of the ENGINEER, such material, article or piece of equipment is of equal substance and function to that specified, the ENGINEER may approve its substitution and use by the CONTRACTOR. Any cost differential shall be deductible from the CONTRACT PRICE and the CONTRACT DOCUMENTS shall be appropriately modified by CHANGE ORDER. The CONTRACTOR warrants that, if substitutes are approved, no major changes in the function or general design of the PROJECT will result. Incidental changes or extra component parts required to accommodate the substitute will be made by the CONTRACTOR without a change in the CONTRACT PRICE or CONTRACT TIME.

## **9 PATENTS**

- a The CONTRACTOR shall pay all applicable royalties and license fees. He shall defend all suits or claims for infringement of any patent rights and save the OWNER harmless from loss on account thereof, except that the OWNER shall be responsible for any such loss when a particular process, design or the product of a particular manufacturer or manufacturers is specified but, if the CONTRACTOR has reason to believe that the design, process or product specified is an infringement of a patent, he shall be responsible for such loss unless he promptly gives such information to the ENGINEER.

## **10 SURVEYS, PERMITS, REGULATIONS**

- a The OWNER shall furnish and establish all base lines for locating the principal component parts of the WORK together with a suitable number of bench marks adjacent to the WORK as shown in the CONTRACT DOCUMENTS. From the information provided by the OWNER, unless otherwise specified in the CONTRACT DOCUMENTS, the CONTRACTOR shall develop and make all detail surveys needed for construction such as cut stakes, offset stakes and other working points, lines, elevations and cut sheets.
- b The CONTRACTOR shall carefully preserve bench marks, reference points and stakes and, in case of willful or careless destruction, he shall be charged with the resulting expense and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.
- c Permits and licenses of a temporary nature necessary for the prosecution of the WORK shall be secured and paid for by the CONTRACTOR. Permits, licenses, and easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the OWNER unless otherwise specified. The CONTRACTOR shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the WORK as drawn and specified. If the CONTRACTOR observes that the CONTRACT DOCUMENTS are at variance therewith, he shall promptly notify the ENGINEER in writing and any necessary changes shall be adjusted as provided in Section 12, CHANGES IN THE WORK.

## **11 PROTECTION OF WORK, PROPERTY AND PERSONS**

- a The CONTRACTOR will supervise and direct the WORK. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The CONTRACTOR will employ and maintain on the WORK a qualified supervisor or superintendent who shall have been designated in writing by the CONTRACTOR as the CONTRACTOR's representative at the site. The supervisor shall have full authority to act on behalf of the CONTRACTOR and all communications given to the supervisor shall be as binding as if given to the CONTRACTOR. The supervisor shall be present on the site at all time as required to perform adequate supervision and coordination of the WORK.
- b The CONTRACTOR will comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction. He will erect and maintain, as required by the conditions and progress of the WORK, all necessary safeguards for safety and protection. He will notify owners of adjacent utilities when prosecution of the WORK may affect them. The CONTRACTOR will remedy all damage, injury or loss to any property caused, directly or indirectly, declared or not, in whole or in part, by the CONTRACTOR, any SUBCONTRACTOR or anyone directly or indirectly employed by any of them, or anyone for whose acts any of them be liable, except damages or loss attributable to the fault of the CONTRACT DOCUMENTS or to the acts or omissions of the OWNER or the ENGINEER or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of the CONTRACTOR.
- c In emergencies affecting the safety of persons or the WORK or property at the site or adjacent thereto, the CONTRACTOR, without special instruction or authorization from the ENGINEER or the OWNER, shall act to prevent threatened damage, injury or loss. He will give the ENGINEER prompt WRITTEN NOTICE of any significant changes in the WORK or deviations from the CONTRACT DOCUMENTS caused thereby, and a CHANGE ORDER shall thereupon be issued covering the changes and deviations involved.

## **12 CHANGES IN THE WORK**

- a The OWNER may at any time, as the need arises, order change within the scope of the WORK without invalidating the contract. If such changes increase or decrease the amount due under the CONTRACT DOCUMENTS, or in the time required for performance of the WORK, an equitable adjustment shall be authorized by CHANGE ORDER.
- b The ENGINEER also may at any time, by issuing a FIELD ORDER, make changes in the details of the WORK. The CONTRACTOR shall proceed with the performance of any changes in the WORK so ordered by the ENGINEER unless the CONTRACTOR believes that such FIELD ORDER entitles him to a change in CONTRACT PRICE or TIME, or both, in which event he shall give the ENGINEER WRITTEN NOTICE thereof within fifteen (15) days after the receipt of the ordered change and the CONTRACTOR shall not execute such changes pending the receipt of an executed CHANGE ORDER or further instruction from the OWNER.

## **13 CHANGES IN CONTRACT PRICE**

- a The CONTRACT PRICE may be changed only by a CHANGE ORDER. The value of any WORK covered by a CHANGE ORDER or of any claim for increase or decrease in the CONTRACT PRICE shall be determined by one or more of the following methods in the order of precedence listed below:

- (1) Unit prices previously approved.
- (2) An agreed lump sum.
- (3) The actual cost for labor, direct overhead, materials, supplies, equipment, and other services necessary to complete the WORK. In addition there shall be added an amount to be agreed upon but not to exceed fifteen percent (15%) of the actual cost of the WORK to cover the cost of general overhead and profit.

#### **14 TIME FOR COMPLETION AND LIQUIDATED DAMAGES**

- a The date of beginning and the time for completion of the WORK are essential conditions of the CONTRACT DOCUMENTS and the WORK embraced shall be commenced on a date specified in the NOTICE TO PROCEED.
- b All CONTRACTS are calendar day length contracts. There are no provisions for weather days. Weather days have been factored into the total days provided in the CONTRACT.
- c Arbitration for the extension of TIME FOR COMPLETION is prohibited.
- d The CONTRACTOR will proceed with the WORK at such rate of progress to insure full completion within the CONTRACT TIME. It is expressly understood and agreed, by and between the CONTRACTOR and the OWNER, that the CONTRACT TIME for the completion of the WORK described herein is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the WORK.
- e If the CONTRACTOR shall fail to complete the WORK within the CONTRACT TIME, or extension of time granted by the OWNER, then the CONTRACTOR will pay to the OWNER the amount for liquidated damages as specified in the BID for each calendar day that the CONTRACTOR shall be in default after the time stipulated in the CONTRACT DOCUMENTS.
- f The CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in completion of the WORK is due to the following and the CONTRACTOR has promptly given WRITTEN NOTICE of such delay to the OWNER or ENGINEER:
  - (1) To any preference, priority or allocation order duly issued by the OWNER.
  - (2) To unforeseeable causes beyond the control and without the fault or negligence of the CONTRACTOR including, but not restricted to, acts of God or of the public enemy, acts of the OWNER, acts of another contractor in the performance of a contract with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes; and
  - (3) To any delays of SUBCONTRACTORS occasioned by any of the causes specified in paragraphs 14.f.(1) and 14.f.(2) of this article.

#### **15 CORRECTION OF WORK**

- a The CONTRACTOR shall promptly remove from the premises all WORK rejected by the ENGINEER for failure to comply with the CONTRACT DOCUMENTS, whether incorporated in the construction or not, and the CONTRACTOR shall promptly replace and re-execute the WORK in accordance with the CONTRACT DOCUMENTS and without expense to the OWNER and shall bear the expense of making good all WORK of other contractors destroyed or damaged by such removal or replacement.
- b All removal and replacement WORK shall be done at the CONTRACTOR's expense. If the CONTRACTOR does not take action to remove such rejected WORK within ten (10) days after receipt of WRITTEN NOTICE, the OWNER may remove such WORK and store the materials at the expense of the CONTRACTOR.

## **16 SUBSURFACE CONDITIONS**

- a The CONTRACTOR shall promptly, and before such conditions are disturbed, except in the event of an emergency, notify the OWNER by WRITTEN NOTICE of:
  - (1) Subsurface or latent physical conditions at the site differing materially from those indicated in the CONTRACT DOCUMENTS; or
  - (2) Unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inhering in WORK of the character provided for in the CONTRACT DOCUMENTS.
- b The OWNER shall promptly investigate the conditions and, if it finds that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for, performance of the WORK, an equitable adjustment shall be made and the CONTRACT DOCUMENTS shall be modified by a CHANGE ORDER. Any claim of the CONTRACTOR for adjustment hereunder shall not be allowed unless he has given the required WRITTEN NOTICE; provided that the OWNER may, if it determines the facts so justify, consider and adjust any such claims asserted before the date of final payment.

## **17 SUSPENSION OF WORK, TERMINATION AND DELAY**

- a The OWNER may, at any time and without cause, suspend the WORK or any portion thereof for a period of not more than ninety days, or such further time as agreed upon by the CONTRACTOR, by WRITTEN NOTICE to the CONTRACTOR and the ENGINEER which notice shall fix the date on which WORK shall be resumed. The CONTRACTOR will resume the WORK on the date so fixed. The CONTRACTOR will be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to any suspension.
- b If the CONTRACTOR is adjudged bankrupt or insolvent, or if he makes a general assignment for the benefit of his creditors, or if a trustee or receiver is appointed for the CONTRACTOR or for any of his property, or if he files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or applicable laws, or if he repeatedly fails to supply sufficient skilled workmen or suitable materials or equipment, or if he repeatedly fails to make prompt payments to SUBCONTRACTORS or for labor, materials or equipment or if he disregards laws, ordinances, rules, regulations or orders of any public body having jurisdiction of the WORK or if he disregards the authority of the ENGINEER, or if he otherwise violates any provision of the CONTRACT DOCUMENTS, then the OWNER may, without prejudice to any other right or remedy and after giving the CONTRACTOR and his surety a minimum of ten (10) days WRITTEN NOTICE, terminate the services of the CONTRACTOR and take possession of the PROJECT and of all materials, equipment, tools, construction equipment and machinery thereon owned by the CONTRACTOR, and finish the WORK by whatever method it may deem expedient. In such case, the CONTRACTOR shall not be entitled to receive any further payment until the WORK is finished. If the unpaid balance of the CONTRACT PRICE exceeds the direct and indirect costs of completing the PROJECT, including compensation for additional professional services, such excess shall be paid to the CONTRACTOR. If such costs exceed such unpaid balance, the CONTRACTOR will pay the difference to the OWNER. Such costs incurred by the OWNER will be determined by the ENGINEER and incorporated in a CHANGE ORDER.
- c Where the CONTRACTOR's services have been so terminated by the OWNER, said termination shall not affect any right of the OWNER against the CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of monies by the OWNER due the

CONTRACTOR will not release the CONTRACTOR from compliance with the CONTRACT DOCUMENTS.

- d After ten (10) days from delivery of a WRITTEN NOTICE to the CONTRACTOR and the ENGINEER, the OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the PROJECT and terminate the contract. In such case, the CONTRACTOR shall be paid for all WORK executed and any expense plus reasonable profit.
- e If, through no act or fault of the CONTRACTOR, the WORK is suspended for a period of more than ninety (90) days by the OWNER or under an order of court or other public authority, or the ENGINEER fails to act on any request for payment within thirty (30) days after it is submitted, or the OWNER fails to pay the CONTRACTOR substantially the sum approved by the ENGINEER or awarded by court order or legal proceeding within thirty (30) days of its approval and presentation, then the CONTRACTOR may, after ten (10) days from delivery of a WRITTEN NOTICE to the OWNER and the ENGINEER, terminate the CONTRACT and recover from the OWNER payment for all WORK executed and all expenses sustained. In addition and in lieu of terminating the CONTRACT, if the ENGINEER has failed to act on a request for payment or if the OWNER has failed to make any payment as aforesaid, the CONTRACTOR may upon ten (10) days' notice to the OWNER and the ENGINEER stop the WORK until he has been paid all amounts then due, in which event and upon resumption of the WORK, CHANGE ORDERS shall be issued for adjusting the CONTRACT PRICE or extending the CONTRACT TIME, or both, to compensate for the costs and delays attributable to the stoppage of the WORK.
- f If the performance of all or any portion of the WORK is suspended, delayed or interrupted as a result of a failure of the OWNER or ENGINEER to act within the time specified in the CONTRACT DOCUMENTS or, if no time is specified, within a reasonable time, adjustment in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, shall be made by CHANGE ORDER to compensate the CONTRACTOR for the costs and delays necessarily caused by the failure of the OWNER or ENGINEER.

## **18 PAYMENTS TO CONTRACTOR**

- a At least ten (10) days before each progress payment falls due (but not more often than once a month), the CONTRACTOR will submit to the ENGINEER a partial payment estimate filled out and signed by the CONTRACTOR covering the WORK performed during the period covered by the partial payment estimate and supported by such data as the ENGINEER may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the WORK but delivered and suitably stored at or near the site, the partial payment estimate shall also be accompanied by such supporting data, satisfactory to the OWNER, as will establish the OWNER's title to the material and equipment and protect its interest therein, including applicable insurance. The ENGINEER will, within ten days after receipt of each partial payment estimate, either indicate in writing his approval of payment and present the partial payment estimate to the OWNER, or return the partial payment estimate to the CONTRACTOR indicating in writing his reasons for refusing to approve payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the partial payment estimate. The OWNER will, within ten (10) days of presentation to him of an approved partial payment estimate, pay the CONTRACTOR a progress payment on the basis of the approved partial payment estimate. The OWNER shall retain five percent (5%) of the amount of each payment until fifty percent (50%) project completion and retain two and a half (2.5%) after to final completion and acceptance of all WORK covered by the CONTRACT DOCUMENTS. On completion and acceptance of a part of the WORK on which the price is

stated separately in the CONTRACT DOCUMENTS, payment may be made in full, including retained percentages, less authorized deductions.

- b The request for payment may also include an allowance for the cost of such major materials and equipment which are suitably stored either at or near the site.
- c All WORK covered by partial payment made shall thereupon become the sole property of the OWNER, but this provision shall not be construed as relieving the CONTRACTOR of the sole responsibility for the care and protection of the WORK upon which payments have been made or the restoration of any damaged WORK, or as a waiver of the right of the OWNER to require the fulfillment of all terms of the CONTRACT DOCUMENTS.
- d Upon completion and acceptance of the WORK, the ENGINEER shall issue a certificate attached to the final payment request that the WORK has been accepted by him under the conditions of the CONTRACT DOCUMENTS. The entire balance found to be due the CONTRACTOR, including the retained percentages, but except such sums as may be lawfully retained by the OWNER shall be paid to the CONTRACTOR within thirty (30) days of completion and acceptance by the OWNER of the WORK.
- e The CONTRACTOR will indemnify and save the OWNER and the OWNER's agents harmless from all claims growing out of the lawful demands of SUBCONTRACTORS, laborers, workmen, mechanics, materialmen and furnishers of machinery and parts thereof, equipment, tools and all supplies incurred in the furtherance of the performance of the WORK. The CONTRACTOR shall, at the OWNER's request, furnish satisfactory evidence that all obligations of the nature designated above have been paid, discharged or waived. If the CONTRACTOR fails to do so the OWNER may, after having notified the CONTRACTOR, either pay unpaid bills or withhold from the CONTRACTOR's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the CONTRACTOR shall be resumed, in accordance with the terms of the CONTRACT DOCUMENTS, but in no event shall the provisions of this sentence be construed to impose any obligations upon the OWNER. Such payment(s) shall be considered as a payment made under the CONTRACT DOCUMENTS by the OWNER to the CONTRACTOR and the OWNER shall not be liable to the CONTRACTOR for any such payments made in good faith.
- f If the OWNER fails to make payment thirty (30) days after approval by the ENGINEER, in addition to other remedies available to the CONTRACTOR, there shall be added to each such payment interest at the maximum legal rate commencing on the first day after said payment is due and continuing until the payment is received by the CONTRACTOR.

## **19 ACCEPTANCE OF FINAL PAYMENT AS RELEASE**

- a The acceptance by the CONTRACTOR of final payment shall be and shall operate as a release to the OWNER of all claims and all liability to the CONTRACTOR other than claims in stated amounts as may be specifically expected by the CONTRACTOR for all things done or furnished in connection with the WORK and for every act and neglect of the OWNER and others relating to or arising out of the WORK. Any payment, however, final or otherwise, shall not release the CONTRACTOR or his sureties from any obligations under the CONTRACT DOCUMENTS or the Bonds.

## 20 INSURANCE

- a The CONTRACTOR shall purchase and maintain such insurance as will protect him from claims set forth below which may arise out of or result from the CONTRACTOR's execution of the WORK, whether such execution be by him or by any SUBCONTRACTOR or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:
  - (1) Claims under worker's compensation, disability benefit and other similar employee benefit acts;
  - (2) Claims for damages because of bodily injury, occupational sickness or disease, or death of his employees;
  - (3) Claims for damages because of bodily injury, sickness or disease or death of any person other than his employees;
  - (4) Claims for damages insured by usual personal injury liability coverage which are sustained (a) by any person as a result of an offense directly or indirectly related to the employment of such person by the CONTRACTOR or (b) by any other person;
  - (5) Claims for damages because of injury to or destruction of tangible property, including loss of use resulting therefrom.
- b Certificates of Insurance acceptable to the OWNER shall be filed with the OWNER prior to commencement of the WORK. These Certificates shall contain a provision that coverages afforded under the policies will not be canceled unless at least fifteen (15) days prior WRITTEN NOTICE has been given to the OWNER.
- c The CONTRACTOR shall procure and maintain, at his own expense, during the CONTRACT TIME, liability insurance as hereinafter specified:
  - (1) CONTRACTOR's General Public Liability and Property Damage Insurance including vehicle coverage issued to the CONTRACTOR and protecting him from all claims for personal injury, including death, and all claims for destruction of or damage to property, arising out of or in connection with any operations under the CONTRACT DOCUMENTS, whether such operations be by him or by any SUBCONTRACTOR under him, or anyone directly or indirectly employed by the CONTRACTOR or by a SUBCONTRACTOR under him. Insurance shall be written with a limit of liability of not less than \$200,000.00 for all damages arising out of bodily injury, including death, at any time resulting therefor, sustained by any one person in any one accident; a limit of liability of not less than \$1,000,000.00 for any such damages sustained by two or more persons in any one accident. Insurance shall be written with a limit of liability of not less than \$100,000.00 for all property damage sustained by any one person in any one accident; and a limit of liability of not less than \$500,000.00 for any such damage sustained by two or more persons in any one accident.
  - (2) The CONTRACTOR shall acquire and maintain, if applicable, Fire and Extended Coverage insurance upon the PROJECT to the full insurable value thereof for the benefit of the OWNER, the CONTRACTOR and SUBCONTRACTORS as their interests may appear. This provision shall in no way release the CONTRACTOR or CONTRACTOR's surety from obligation under the CONTRACT DOCUMENTS to fully complete the PROJECT.
- d The CONTRACTOR shall procure and maintain, at his own expense, during the CONTRACT TIME, in accordance with the provision of the laws of Oklahoma, Worker's Compensation Insurance, including occupational disease provisions, for all of his employees at the site of the

PROJECT and, in case any work is sublet, the CONTRACTOR shall require all SUBCONTRACTORS similarly to provide Worker's Compensation Insurance, including occupational disease provisions for all of the latter's employees unless such employees are covered by the protection afforded by the CONTRACTOR. In case any class of employees engaged in hazardous work under this contract at the site of the PROJECT is not protected under Worker's Compensation statute, the CONTRACTOR shall provide and shall cause each SUBCONTRACTOR to provide adequate and suitable insurance for the protection of his employees not otherwise protected.

- e The CONTRACTOR shall secure, if applicable, "All Risk" type Builder's Risk Insurance for the WORK to be performed. Unless specifically authorized by the OWNER, the amount of such insurance shall not be less than the CONTRACT PRICE totaled in the BID. The policy shall cover not less than the losses due to fire, explosion, hail, lightning, vandalism, malicious mischief, wind, collapse, riot, aircraft and smoke during the CONTRACT TIME, and until the WORK is accepted by the OWNER. The policy shall name as insured the CONTRACTOR, the ENGINEER and the OWNER.

## **21 CONTRACT SECURITY**

- a The CONTRACTOR shall within ten (10) days after the receipt of the NOTICE OF AWARD furnish the OWNER with a Performance Bond and a Statutory Bond in penal sums equal to the amount of the CONTRACT PRICE, conditioned upon the performance by the CONTRACTOR of all undertakings, covenants, terms, conditions and agreements of the CONTRACT DOCUMENTS, and upon the prompt payment by the CONTRACTOR to all persons supplying labor and materials in the prosecution of the WORK provided by the CONTRACT DOCUMENTS. Such BONDS shall be executed by the CONTRACTOR and a corporate bonding company licensed to transact such business in the state in which the WORK is to be performed. The expense of these BONDS shall be borne by the CONTRACTOR. If at any time a surety on any such BOND is declared a bankrupt or loses its right to do business in the state in which the WORK is to be performed, CONTRACTOR shall within ten (10) days after notice from the OWNER to do so, substitute an acceptable BOND (or BONDS) in such form and sum signed by such other surety or sureties as may be satisfactory to the OWNER. The premiums on such BOND shall be paid by the CONTRACTOR. No further payments shall be deemed due nor shall be made until the new surety or sureties shall have furnished an acceptable BOND to the OWNER.

## **22 ASSIGNMENTS**

- a Neither the CONTRACTOR nor the OWNER shall sell, transfer, assign or otherwise dispose of the contract or any portion thereof, or of his right, title or interest therein, or his obligations thereunder, without written consent of the other party.

## **23 INDEMNIFICATION**

- a The CONTRACTOR will indemnify and hold harmless the OWNER and the ENGINEER and their agents and employees from and against all claims, damages, losses and expenses including attorneys' fees arising out of or resulting from the performance of the WORK provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, including the loss of use resulting therefrom; and is caused in whole or in part by any negligent or willful



act or omission of the CONTRACTOR, and/or SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

- b In any and all claims against the OWNER or the ENGINEER, or any of their agents or employees, by any employee of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by and for the CONTRACTOR or any SUBCONTRACTOR under worker's compensation acts, disability benefit acts or other employee benefit acts.
- c The obligation of the CONTRACTOR under this paragraph shall not extend to the liability of the ENGINEER, his agents or employees arising out of the preparation or approval of maps, DRAWINGS, opinions, reports, surveys, CHANGE ORDERS, designs or SPECIFICATIONS.
- d The OWNER is covered by the Oklahoma Tort Claims Act at 51 O.S. Sec. 151 *et seq.* Any claims for damages against the OWNER must be filed and comply with the requirement of the Oklahoma Tort Claims Act.

## **24 SEPARATE CONTRACTS**

- a The OWNER reserves the right to let other contracts in connection with this PROJECT. The CONTRACTOR shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate his WORK with theirs. If the proper execution or results of any part of the CONTRACTOR's WORK depends upon the work of any other contractor, the CONTRACTOR shall inspect and promptly report to the ENGINEER any defects in such work that render it unsuitable for such proper execution and results.
- b The OWNER may perform additional work related to the PROJECT, or it may let other contracts containing provisions similar to these. The CONTRACTOR will afford the other contractors who are parties to such contracts (or the OWNER, if it is performing the additional work itself) reasonable opportunity for the introduction and storage of materials and equipment and the execution of work, and shall properly connect and coordinate its WORK with theirs.
- c If the performance of additional work by other contractors or the OWNER is not noted in the CONTRACT DOCUMENTS prior to the execution of the contract, written notice thereof shall be given to the CONTRACTOR prior to starting any such additional work. If the CONTRACTOR believes that the performance of such additional work by the OWNER or others involves him in additional expense or entitles him to an extension of the CONTRACT TIME, he may make a claim therefor as provided in Sections 13 and 14.

## **25 SUBCONTRACTING**

- a The CONTRACTOR may utilize the services of specialty SUBCONTRACTORS on those parts of the WORK that, under normal contracting practices, are performed by specialty SUBCONTRACTORS.
- b The CONTRACTOR shall not award WORK to SUBCONTRACTOR(S) in excess of fifty percent (50%) of the CONTRACT PRICE, without prior written approval of the OWNER.

- c The CONTRACTOR shall be fully responsible to the OWNER for the acts and omissions of his SUBCONTRACTORS, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.
- d The CONTRACTOR shall cause appropriate provisions to be inserted in all subcontracts relative to the WORK to bind SUBCONTRACTORS to the CONTRACTOR by the terms of the CONTRACT DOCUMENTS insofar as applicable to the WORK of SUBCONTRACTORS and to give the CONTRACTOR the same power as regards terminating any subcontract that the OWNER may exercise over the CONTRACTOR under any provision of the CONTRACT DOCUMENTS.
- e Nothing contained in this contract shall create any contractual relation between any SUBCONTRACTOR and the OWNER.
- f The OWNER will not recognize any SUBCONTRACTOR on the WORK. The CONTRACTOR shall at all times when work is in progress be represented at the site either in person or by a qualified and approved superintendent who shall be in direct charge of all operations on the contract whether performed directly by the CONTRACTOR or the SUBCONTRACTOR.

## **26 ENGINEER'S AUTHORITY**

- a The ENGINEER shall act as the OWNER's representative during the construction period. He shall decide questions which may arise as to quality and acceptability of materials furnished and WORK performed. He shall interpret the intent of the CONTRACT DOCUMENTS in a fair and unbiased manner. The ENGINEER will make visits to the site and determine if the WORK is proceeding in accordance with the CONTRACT DOCUMENTS.
- b The CONTRACTOR will be held strictly to the intent of the CONTRACT DOCUMENTS in regard to the quality of materials, workmanship and execution of the WORK. Inspections may be made at the factory or fabrication plant of the source of material supply.
- c The ENGINEER will not be responsible for the construction means, controls, techniques, sequences, procedures or construction safety.
- d The ENGINEER shall promptly make decisions relative to interpretation of the CONTRACT DOCUMENTS.

## **27 LAND AND RIGHTS-OF-WAY**

- a Prior to issuance of the NOTICE TO PROCEED, the OWNER shall obtain all land and rights-of-way necessary for carrying out and for the completion of the WORK to be performed pursuant to the CONTRACT DOCUMENTS, unless otherwise mutually agreed.
- b The OWNER shall provide to the CONTRACTOR information which delineates and describes the lands owned and rights-of-way acquired.
- c The CONTRACTOR shall provide at his own expense and without liability to the OWNER any additional land and access thereto that the CONTRACTOR may desire for temporary construction facilities or for storage of materials.

## **28 GUARANTY**

- a The CONTRACTOR shall guarantee all materials and equipment (including settlement or washing out of any backfill, leaks, etc.) furnished and WORK performed for a period of

two (2) years from the date of SUBSTANTIAL COMPLETION. The CONTRACTOR warrants and guarantees for a period of two (2) years from the date of SUBSTANTIAL COMPLETION of the WORK that the completed WORK is free from all defects due to faulty materials or workmanship and the CONTRACTOR shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any damage to other parts of the WORK resulting from such defects. The OWNER will give notice of observed defects with reasonable promptness. In the event that the CONTRACTOR should fail to make such repairs, adjustments or other WORK that may be made necessary by such defects, the OWNER may do so and charge the CONTRACTOR the cost thereby incurred. The Performance Bond shall remain in full force and effect through the guarantee period.

## **29 GRADING AND CLEANING OF WORK SITE**

- a Before final acceptance of the WORK by the OWNER, the work site shall be graded in an approved manner. All rubbish, materials of construction, CONTRACTOR's equipment, etc. shall be removed from the work site.
- b Any privately owned facility (sprinkler lines, etc.) damaged by the CONTRACTOR, even located in the right of way, shall be replaced or repaired at the CONTRACTOR'S expense.

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**SECTION C**  
**CONSTRUCTION SPECIFICATIONS**

**GENERAL DESCRIPTION OF WORK**

The work to be performed under the provisions of these contract documents consists of furnishing all materials, equipment, tools and plant; and the performance of all necessary labor and services to construct as shown in the Plans.

**LIQUIDATED DAMAGES**

Liquidated damages shall be assessed at the rate of one hundred dollars (\$100.00) per consecutive calendar day effective midnight on the last day of the contract as stated on the Notice to Proceed. No maximum limit.

**JOB SITE MAINTENANCE, SEDIMENT CONTROL, EROSION PREVENTION, AND OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY REQUIREMENTS**

The Contractor shall provide and maintain sediment controls in accordance with state requirements as directed by the engineer and as indicated on the plans to prevent sediment from leaving the work area. Sediment controls shall be maintained at all times to the satisfaction of the engineer for the duration of the project. The costs for sediment controls shall not be paid separately but shall be included in the price bid for other items of work and shall include labor and materials necessary to accomplish installation and maintenance of the devices for the duration of the project.

For all projects that disturb 1 or more acres, either directly through actual construction and/or indirectly through construction related activities, such as construction of material storage areas and/or other temporary facilities incidental to construction, the Contractor shall file the required Oklahoma Department of Environmental Quality (ODEQ) notice of intent (NOI) prior to construction and the notice of termination (NOT) upon completion of restoration of the areas disturbed. Areas disturbed for right-of-way or easement clearing; excavations; material deliveries, stockpiling or storage; construction trailers with appurtenant parking areas and driveways; and other construction related activities shall be included in the estimate of disturbed area for the project. **Issuance of the notice to proceed for this project is contingent upon receipt of a copy of the N.O.I. filed with the state.**

**ODEQ acceptance of the N.O.T. must be on file with the owner before the retainage is paid out.**

The direct and indirect costs associated with the necessary permitting shall not be paid for as such, but shall be included in the price bid for other items of work. Any and all corrective orders issued and/or fines assessed by the ODEQ and/or United States Environmental Protection Agency (EPA) in response to violation of the NOI shall be solely at the Contractor's expense and at no expense to the owner.

**BASIS OF PAYMENT**

The "Unit Prices" described herein shall be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans, these specifications and the referenced Oklahoma Department of Environmental Quality (ODEQ) OAC Title 252 Chapter 656 "Water Pollution Control Facility Construction Standards" and Chapter 626 "Public Water Supply Construction Standards", Midwest City's Sewer Main Installation Specifications and Water Main Installation Specifications, and 2019 Oklahoma Department of Transportation (ODOT) Standard Specifications For Highway Construction. This specification book and the referenced Midwest City specifications govern over the minimum ODEQ and ODOT specifications. The ODOT standard

specifications apply only with respect to materials, construction methods and testing. All work not classified as a contract pay item shall be considered incidental construction and the cost for such shall be included in the price bid for other items of work.

### **MEASUREMENT AND PAYMENT**

The method of measurement and basis of payment for each item listed in the bid shall be as stipulated Specification Section 01 29 00 Measurement and Payment.

Under each item, the Contractor shall furnish, construct, and install in place all items as shown on the plans or as directed by the engineer or city inspector.

**End of Section**

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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**THIS CONSTRUCTION SERVICES AGREEMENT** (hereinafter referred to as “**Agreement**”) is entered into by and among The City of Midwest City, a municipal corporation (hereinafter referred to as “**City**”), and \_\_\_\_\_, (hereinafter referred to as “**Service Provider**”) (**City**, and **Service Provider** being collectively referred to herein as the “**Parties**”) and is effective upon the date of execution by the last party hereto.

**WITNESSETH:**

**WHEREAS**, **City** is in need of the following construction services NORTH SIDE UTILITIES SANITARY SEWER PROJECT; and

**WHEREAS**, **Service Provider** is in the business of providing construction services that is needed by the **City**; and

**WHEREAS**, the **City** and the **Service Provider** have reached an agreement for the **Service Provider** to provide the **City** the requested construction services; and

**WHEREAS**, **City** hereby retains **Service Provider** to provide construction services as an independent contractor; and

**WHEREAS**, **Service Provider** agrees to provide the **City** all services, in accordance with the standards exercised by experts in the field, necessary to provide the **City** services, products, solutions and deliverables that meet all the purposes and functionality requested or described in the RFP and in this Agreement.

**NOW, THEREFORE**, for and in consideration of the above premises and mutual covenants as set forth herein, the **City**, and **Service Provider** hereby agree as follows:

**1. INDEPENDENT CONTRACTOR STATUS**

Subject to the terms and conditions of this Agreement, the City retains the Service Provider as an independent contractor, to provide **City** all services, in accordance with the standards exercised by experts in the field, necessary to provide the City services, products,

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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solutions, and deliverables (collectively referred to as “Deliverables”) that meet all the purposes and functionality requested or described in this Agreement. The **City** shall meet with **Service Provider** to identify service needs on a project by project basis. **Service Provider** will provide a written proposal for the identified services in accord with the terms and conditions of this Agreement. The **City** may issue a purchase order for the identified services accompanied by **Service Provider’s** written proposal. Upon issuance of the purchase order, the **Service Provider** shall be responsible for timely providing the services authorized by the purchase order (“Project”). Upon completion of the Project (services in a purchase order), the **Service Provider** will issue an invoice to the **City** and, upon approval of the invoice, the **City** will pay the invoice. Upon completion of each Project and provision to the **City** of all Deliverables for that Project and payment of the invoice for that Project to the **Service Provider**, the **City** shall own all rights and license for the Deliverables and other work products related to that Project.

a) This Agreement governs the Scope of Services including, but not limited to, all Deliverables to be provided by **Service Provider** to the **City**. The Attachments are incorporated into this Agreement by reference and, should there be a conflict in language, terms, conditions, or provisions, shall have the priority and precedential value as set forth in this Agreement.

b) The text of this Agreement together with the Attachments constitutes the entire Agreement and the only understanding and agreement between the **City** and the **Service Provider** with respect to the services, products, solutions and deliverables to be provided by the **Service Provider** hereunder. This Agreement may only be amended, modified or changed in writing when signed by all parties, or their respective specifically authorized representatives, as set forth in this Agreement.

c) If there is a conflict in language, terms, conditions, or provisions, in this Agreement



**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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between the text of this document, and any language, term, condition, or provision in any Attachment, then the text of this document, shall govern and control over any conflicting language, term, condition, or provision in any Attachment. As among the Attachments any conflict in the language, terms, conditions, or provisions shall be governed in the following order of priority and precedence:

- Attachment “A” (“Scope of Services”)
- Attachment “B” (“Schedule of Fees / Rate Card”),
- Attachment “C” (“**Service Provider’s Team**”),
- Attachment “D” (“Insurance”).

**2. RETENTION OF SERVICES PROVIDER AND SCOPE OF SERVICES**

A. **Service Provider** is solely responsible for the actions, non-action, omissions, and performance of **Service Provider’s** employees, agents, contractors, and subcontractors (herein collectively included in the term “Service Provider’s Project Team”) and to ensure the timely provision of each Project, timely performance of the Scope of Services, and the timely performance of each Project and the provision of all Deliverables as each are defined in **Attachment “A” (“Scope of Services”)** or the Project.

B. **Service Provider** will be solely responsible to ensure the **Service Provider’s Project Team** fully understands each Project, the Scope of Services, the Deliverables, the schedule for performance, and **City’s** goals and purposes. Service Provider will be solely responsible to ensure the **Service Provider’s Team**, specifically assigned to work on the Project for the City, is adequately trained, instructed, and managed so that **Service Provider** timely provides each Project task and satisfies the **Service Provider’s** obligations under this Agreement. The **Service Provider** may not change the **Service Provider’s Team**, for the services to be provided as set forth on Attachment “C” (“**Service Provider’s Team**”) without the prior written consent of the **City**.

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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C. **Service Provider** shall comply with all applicable federal, state and local laws, standards, codes, ordinances, administrative regulations and all amendments and additions thereto, pertaining in any manner to the performance or services provided under this **Agreement**. **Service Provider** shall obtain all patents, licenses and any other permission required to provide all Deliverables and for use of all Deliverables by the **City**.

**3. CONSIDERATION**

A. The **City** shall pay the **Service Provider** the compensation after completion of Projects or Deliverables as specified in Attachment “B” (“**Schedule of Fees / Rate Card**”).

B. The **City** and the **Service Provider** acknowledge that the compensation to be paid the **Service Provider** pursuant to this **Agreement** has been established at an amount reasonable for the availability and services of the **Service Provider and the Service Provider’s Team**.

**4. INDEPENDENT CONTRACTOR STATUS**

The parties hereby acknowledge and covenant that:

A. **Service Provider** is an independent contractor and will act exclusively as an independent contractor is not an agent or employee of the **City** in performing the duties in this Agreement.

1. The parties do not intend, and will not hold out that there exists, any corporation, joint venture, undertaking for a profit or other form of business venture or any employment relationship among the parties other than that of an independent contractor relationship.

2. All payments to **Service Provider** pursuant to this **Agreement** shall be due and payable in the State of Oklahoma, even if services of **Service Provider** are performed outside the State of Oklahoma.

B. The **City** shall not withhold any social security tax, workmen’s compensation, Medicare tax, federal unemployment tax, federal income tax, or state income tax from any compensation paid to **Service Provider** as **Service Provider** is an independent contractor and

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
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the members of its **Service Provider’s Team**, assigned to work on the Project for the **City** are not employees of the **City**. Any such taxes, if due, are the responsibilities of **Service Provider** and will not be charged to the **City**.

C. **Service Provider** acknowledges that as an independent contractor it and **Service Provider’s Project Team**, assigned to work on the Project for the **City** are not eligible to participate in any health, welfare or retirement benefit programs provided by the **City** or its employees.

**5. TERM, TERMINATION AND STOP WORK**

A. This **Agreement** shall commence upon execution by the last party hereto and shall continue in effect for one-year from the date of execution, unless terminated by either party as provided for herein. This **Agreement** may be extended by mutual agreement of the **Parties** in one-year increments, until the Project is completed and accepted as provided herein.

B. The **City** issue notices of termination or suspension to the **Service Provider**. This **Agreement** may be terminated, with or without cause, upon written notice, at the option of **City**.

1. Upon receipt of a notice of termination for the *convenience* from the **City**, the **Service Provider** shall immediately discontinue all services and activities (unless the notice directs otherwise), and

2. Upon payment for products or services fully performed and accepted, **Service Provider** shall deliver to the **City** all licenses, work, products, deliverables, solutions, communication recommendations, plans, messaging strategies, style guides, design elements, internal and external messaging campaigns, documents, data analysis, reports, and other information and materials accumulated or created in performing this **Agreement**, whether same are complete or incomplete, unless the notice directs otherwise. Upon termination for the *convenience* by the **City**, the **City** shall pay **Service Provider** for completed Projects and Deliverables up to the time of the notice of termination for *convenience*, in accordance with the

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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terms, limits and conditions of the **Agreement** and as further limited by the “not to exceed” amounts set out in this **Agreement**.

3. Upon notice of termination for *cause* from the **City**, the **Service Provider** shall not be entitled to any prior or future payments, including, but not limited to, any services, performances, work, products, deliverables, solutions, costs, or expenses, and **Service Provider** shall release and waive any interest in any retainage. The **City** may hold any outstanding payments for prior completed Projects, Deliverables, Services or expenses and any retainage as security for payment of any costs, expenses, or damages incurred by the **City** by reason of **Service Provider’s** breach or other cause. Provided, however, upon notice of termination for cause, the **Service Provider** shall deliver to the **City** services, products, solutions, and Deliverables including, but limited to, all communication recommendations, plans, messaging strategies, style guides, design elements, internal and external messaging campaigns, documents, data analysis, reports, and other information and materials accumulated or created in performing this **Agreement**, whether complete or incomplete, unless the notice directs otherwise.

4. The rights and remedies of the **City** provided in this paragraph are in addition to any other rights and remedies provided by law or under the **Agreement**. Termination herein shall not terminate or suspend any warranty, indemnification, insurance, or confidentiality required to be provided by **Service Provider** under this **Agreement**.

C. Upon notice to **Service Provider**, the **City** may issue a stop work order suspending any Projects, services, performances, work, products, Deliverables, or solutions under this **Agreement**. Any stop work order shall not terminate or suspend any warranty, indemnification, insurance, or confidentiality required to be provided by **Service Provider** under this **Agreement**. In the event the **City** issues a stop work order to **Service Provider**, the **City** will provide a copy of such stop work order to the **Service Provider**. Upon receipt of a stop work order issued from the **City**, the **Service Provider** shall suspend all work, services and activities except such

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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work, services, and activities expressly directed by the **City** in the stop work order. Upon notice to the **Service Provider**, this **Agreement**, and any or all work, services, and activities thereunder, may be suspended up to thirty (30) calendar days by the **City**, without cause and without cost to the **City**; provided however, the **Service Provider** shall be entitled to an extension of all subsequent deadlines for a period equal to the suspension periods for those suspended work, services, and activities only.

**D. Obligation upon Termination for *Convenience*.**

1. In the event this **Agreement** is terminated for convenience hereunder, the **City** shall pay **Service Provider** for such properly documented invoices, if any, in accordance with the provisions of this **Agreement** above, through the date of termination for *convenience* and the period set forth in the notice, and thereafter the **City** shall have no further liability under this **Agreement** to **Service Provider** and **Service Provider** shall have no further obligations to the **City**.

2. Upon termination for *convenience* of the Project and the providing to the **City** of all Deliverables for the Project and payment of the invoice for the Project to **Service Provider**, the **City** shall own all rights and license for the Deliverables and other work products related to that Project.

**6. WARRANTIES**

A. **Service Provider** warrants that the Projects performed and Deliverables provided under this **Agreement** shall be performed consistent with generally prevailing professional standards and expertise. **Service Provider** shall maintain during the course of this **Agreement** said standard of care, expertise, skill, diligence and professional competency for any and all such services, products, solutions and deliverables. **Service Provider** agrees to require all members of the **Service Provider's Team**, also including FTEs assigned to work on the Project, to provide any and all services, products, solutions and Deliverables at said same standard of care, expertise, skill, diligence and professional competence required of **Service Provider**.

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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B. During the term of this **Agreement**, the **City's** initial remedy for any breach of the above warranty shall be to permit **Service Provider** one additional opportunity to perform the work, services, and activities or provide the Projects and Deliverables without additional cost to the **City**. If the **Services Provider** cannot perform the work, services, and activities or provide the products, solutions and deliverables according to the standards and requirements set forth in this **Agreement** within thirty (30) calendar days of the original performance date, the **City** shall be entitled to recover, should the **City** so determine to be in their best interest, any fees paid to the **Service Provider** for previous payments, including, but not limited to, work, services, activities services, Projects and Deliverables and **Service Provider** shall make reimbursement or repayment within thirty (30) calendar days of a demand by the **City**. Should the **Service Provider** fail to reimburse the **City** within thirty (30) calendar days of demand, the **City** shall also be entitled to interest at 1.5% percent per month on all outstanding reimbursement and repayment obligations.

C. The **Service Provider** also acknowledges and agrees to provide all express and implied, warrants required or provided for by Oklahoma statutory and case law. This warrant is in addition to other warranties provided in or applicable to this **Agreement** and may not be waived by any other provision, expressed or implied, in this **Agreement** or in any **Attachment** hereto.

## **7. INSURANCE**

A. **Service Provider** must provide and maintain at all times throughout the term of this **Agreement**, and any renewal hereof, such *commercial general insurance with a limit of \$1,000,000 per occurrence for bodily injury and property damage and \$5,000,000 general aggregate* protecting the **City** from claims for bodily injury (*including death*) and or property damage arising out of or resulting from the **Service Provider**, and its employees, use and occupancy of the premises and the activities conducted thereon . The insurance coverage required in this paragraph must include the **City** as additional insureds as their interest may appear under

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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this **Agreement** under the policy or policies.

B. A certificate of insurance evidencing the coverage required herein shall be provided to the **City** within five (5) days of the execution of this **Agreement**.

C. **Service Provider** shall require any contractor or subcontractor to obtain and maintain substantially the same coverage as required of **Service Provider** including the **City** as an additional insured as their interest may appear under this **Agreement**.

D. The insurance requirements set forth herein must not be deemed to limit, affect, waive, or define any obligations of the **Service Provider** in any other paragraph of this **Agreement** or any indemnification or insurance requirement in any other paragraph of this **Agreement**. This paragraph must continue in full force and affect for any act, omission, incident or occurrence occurring or commencing during the term of this **Agreement**. Further, the insurance coverage required by this paragraph will survive revocation, non-renewal, termination and expiration of this **Agreement** for any occurrence or event occurring, initiated, or commencing prior to such revocation, non-renewal, termination and expiration or during the period in which the **Service Provider** is services under the **Agreement**.

E. Provided, however, should the **Service Provider** or its officers, invitees, representatives, contractors, employees or agents carry any additional, different or other insurance or insurance coverage of any kind or nature, the provisions of this paragraph must not in any way limit, waive or inhibit the **City** from making a claim or recovering under such insurance or insurance coverage.

F. Notwithstanding any other provision to the contrary, upon termination or lapse of insurance coverage required hereunder, this **Agreement** may be terminated. Termination of this **Agreement** pursuant to this paragraph must take precedence and supersede any other paragraph establishing the term of this **Agreement**, establishing a procedure for revocation or termination, or requiring notice and/or providing an opportunity to cure a breach.

G. The insurance limits in this paragraph in no way act or will be deemed to define or limit the right of **City** to recover damages, expenses, losses or for personal injuries, death or

**CONSTRUCTION SERVICES AGREEMENT**  
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property damage pursuant to applicable law or the indemnification provisions or under any other paragraph or provision in this **Agreement**.

**8. INDEMNIFICATION**

A. **Service Provider** agrees to indemnify, defend, and hold harmless the **City** from and against all liability for: (a) injuries or death to persons; (b) costs, losses, and expenses; (c) legal fees, legal expenses, and court costs; and (d) damages, loss to property, which are caused by the **Service Provider**, its officers, representatives, agents, contractors, and employees except to the extent such injuries, losses, damages and/or costs are caused by the negligence or willful misconduct of the indemnified party. The **Service Provider** must give the **City** prompt and timely notice of any claim or suit instituted which in any way, directly or indirectly, contingently or otherwise, affects or might affect the **City**, provided, however, such notice will not be a precondition to indemnification hereunder. The rights granted by this paragraph will not limit, restrict, or inhibit the rights of the **City** under any other paragraph, including but not limited to any insurance provision or requirement in this **Agreement**.

B. The provisions of this paragraph shall survive the expiration of this **Agreement**. It is understood that these indemnities and hold harmless provisions are not limited or defined by the insurance required under the insurance provisions of this **Agreement**.

**9. CONFIDENTIALITY**

**Service Provider** acknowledges that in the course of training and providing other services to the **City**, the **City** may provide **Service Provider** with access to valuable information of a confidential and proprietary nature including but not limited to information relating to the **City's** employees, customers, marketing strategies, business processes and strategies, security systems, data and technology. **Service Provider** agrees that during the time period this **Agreement** is in effect, and thereafter, neither **Service Provider** nor **Service Provider's Team**, without the prior written consent of the **City**, shall disclose to any person, other than to the **City**, any



**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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information obtained by **Service Provider**. **Service Provider** shall require and maintain adequate confidentiality agreements with its employees, agents, contractors, and subcontractors.

**10. NOTICES**

A. Notices and other communications to the **City** pursuant to the provisions hereof will be sufficient if sent by first class mail, postage prepaid, return receipt required, or by a nationally recognized courier service, addressed to:

The City of Midwest City, City Clerk  
100 N. Midwest Boulevard  
Midwest City, OK 73110

respectively, and notices or other communications to the **Service Provider** pursuant to the provisions hereof will be sufficient if by first class mail, postage prepaid, return receipt required, or by a nationally recognized courier service, addressed to:

\_\_\_\_\_  
(Contact Person name for Service Provider)  
\_\_\_\_\_  
(Name of Service Provider)  
\_\_\_\_\_  
(street or mailing address for service provider)  
\_\_\_\_\_  
(City, State and zip code for service provider)

B. Any party hereto may change the address or addressee for the giving of notice to it by thirty (30) days prior written notice to the other parties hereto as provided herein. Unless otherwise specified in this **Agreement**, notice will be effective upon actual receipt or refusal as shown on the receipt obtained pursuant to this paragraph.

**11. ABIDES BY LAW**

The **Service Provider** must abide by the conditions of this **Agreement**, the ordinances of the **City**, and all laws and regulations of the State of Oklahoma and the United States of America (“Laws”), applicable to **Service Provider’s** activities. **Service Provider** will be responsible for

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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securing any license, permits and/or zoning which may be required prior to commencement of the Project.

**12. ASSIGNMENT AND SUBLEASE**

**Service Provider** may not assign or sublease its interest under this **Agreement** without the prior written consent of the **City**. Any assignment or sublease shall become effective upon receipt of a request signed by authorized and empowered officers/agents of the **Service Provider** and sublessee and provision by the sublessee of a certificate of insurance evidencing the insurance required by this **Agreement** and upon approval of such sublease by **City**. The **City** may, but not required, to execute a letter approving either the assignment or sublease as provided herein on behalf of **City**. Upon approval of such assignment or sublease, **Service Provider** will not be relieved of future performance, liabilities, and obligations under this **Agreement**. **City** shall be provided with a copy of each written sublease agreement, and all amendments thereto, entered into by **Service Provider** within forty-five (45) days after the entering into of same.

**13. COMPLETE AGREEMENT AND AMENDMENT**

This is the complete agreement between the parties and no additions, amendments, alterations, or changes in this **Agreement** shall be effective unless reduced to writing and signed by all parties hereto. Additionally, no statements, discussions, or negotiations shall be deemed or interpreted to be included in this **Agreement**, unless specifically and expressly provided herein.

**14. TIME OF ESSENCE**

For the purposes of this **Agreement**, time shall be deemed to be of the essence.

**15. MULTIPLE ORIGINALS**

This **Agreement** shall be executed in multiple counterparts, each of which shall be deemed an original.

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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**16. ANTI-COLLUSION**

**Service Provider** agrees that it has not been and shall not be a party to any collusion with any of their officials, trustees, or employees of the **City** as to the terms or conditions of this **Agreement**, and has not and will not exchange, give or donate money or other things of value for special consideration to any officials, trustees, or employees of the **City**, either directly or indirectly, in procuring and execution of this **Agreement**.

**17. BREACH AND DEFAULT**

A. A breach of any provision of this **Agreement** shall act as a breach of the entire **Agreement** unless said breach is expressly waived in writing by all other parties hereto. Failure to enforce or timely pursue any breach shall not be deemed a waiver of that breach or any subsequent breach. No waiver of any breach by any party hereto of any terms, covenants, or conditions herein contained shall be deemed a waiver of any subsequent breach of the same, similar, or different nature.

B. Further, except as otherwise specifically and expressly provided and any other paragraph hereto, should any party hereto fail to perform, keep or observe any of the terms, covenants, or conditions herein contained, this **Agreement** may be terminated by any party not in default thirty (30) days after receipt of written notice and opportunity to cure, less and except as such lesser time is provided in this **Lease**.

C. Should the **City** breach this **Agreement**, **Service Provider** may only recover that proportion of services provided prior to the breach. **Service Provider** may not collect or recover any other or additional damages, losses, or expenses.

**18. THIRD PARTY BENEFICIARIES**

All parties expressly agree that no third-party beneficiaries, expressly or implicitly, are intended to be or shall be created or acknowledged by this **Agreement**. This **Agreement** is solely

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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for the benefit of the **Service Provider** and the **City**, and none of the provisions hereof are intended to benefit any third parties.

**19. VENUE AND CHOICE OF LAW**

All parties hereto expressly agree that the venue of any litigation relating to or involving this **Agreement** and/or the rights, obligations, duties and covenants therein shall be in the appropriate court (state or federal) located in Oklahoma County, Oklahoma. All parties agree that this **Agreement** shall be interpreted and enforced in accordance with Oklahoma law and all rights of the parties shall be determined in accordance with Oklahoma law.

**20. VALIDITY**

The invalidity or unenforceability of any provision of this **Agreement** shall not affect the validity or enforceability of any other provisions of this **Agreement**, which shall remain in full force and effect.

**21. NO WAIVER**

The failure or neglect of either of the **Parties** hereto to insist, in any one or more instances, upon the strict performance of any of the terms or conditions of this **Agreement**, or waiver by any party of strict performance of any of the terms or conditions of this **Agreement**, shall not be construed as a waiver or relinquishment in the future of such term or condition, but such term or condition shall continue in full force and effect.

**22. NO EXTRA WORK**

No claims for extra work, product, services, solution, or deliverables of any kind or nature or character shall be recognized or paid by or be binding upon the **City** unless such services, work, product, solution, or deliverable is first requested and approved in writing by the **City** through a purchase order.

**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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**23. AMENDMENT**

This **Agreement** may be amended by mutual agreement of the **Parties**, in writing and signed by both **Parties**. The **City** hereby delegates to the City Manager all amendments to this **Agreement** for approval and execution, unless the amendment would increase the contracted amount by more than ten percent (10%).

**24. EFFECTIVE DATE**

The Effective Date of this **Agreement** is the date approved by the **City** as the last party hereto.

*[REMAINDER OF THIS PAGE INTENTIONALLY LEFT BANK]*

**CONSTRUCTION SERVICES AGREEMENT  
between**

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**And  
THE CITY OF MIDWEST CITY**

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IN WITNESS WHEREOF, the parties have caused their properly authorized representatives to execute this **Agreement** on the dates set forth below.

**Service Provider:** \_\_\_\_\_ (Name of Service Provider)

By: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

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**CONSTRUCTION SERVICES AGREEMENT**  
**between**

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**And**  
**THE CITY OF MIDWEST CITY**

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**APPROVED** by the Council and **SIGNED** by the Mayor of The City of Midwest City this  
\_\_\_\_\_ day of \_\_\_\_\_, 2023.

**THE CITY OF MIDWEST CITY**

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**MAYOR**

---

SARA HANCOCK, CITY CLERK

**REVIEWED** for form and legality.

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DONALD D. MAISCH, CITY ATTORNEY

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**STATUTORY BOND**

KNOW ALL BY THESE PRESENTS:

That \_\_\_\_\_, as Principal, and \_\_\_\_\_, a corporation organized under the laws of the State of \_\_\_\_\_, and authorized to transact business in the State of Oklahoma, as Surety, are held and firmly bound unto the City of Midwest City in the penal sum of \_\_\_\_\_ Dollars (\$\_\_\_\_\_) in lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves and each of us, our heirs, executors, administrators, trustees, successors, and assigns, jointly and severally, firmly by these presents.

DATED this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

The condition of this obligation is such that:

WHEREAS, Principal entered into a written contract with the City of Midwest City dated \_\_\_\_\_, 2023, for:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

all in compliance with the plans and specifications therefor, made a part of said Contract and on file in the office of the City Clerk, City of Midwest City, 100 N. Midwest Boulevard, Midwest City, Oklahoma 73110.

NOW, THEREFORE, if Principal shall fail or neglect to pay all indebtedness incurred by Principal or subcontractors of Principal who perform work in the performance of said contract for labor and materials and repairs to and parts for equipment used and consumed in the performance of said Contract within thirty (30) days after the same becomes due and payable, the person, firm or corporation entitled thereto may sue and recover on this bond the amount so due and unpaid.

It is further expressly agreed and understood by the parties to said Contract that no changes or alterations in said Contract and no deviations from the plan or mode of procedure herein fixed shall have the effect of releasing the sureties, or any of them, from the obligations of this Bond.

IN WITNESS WHEREOF, Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact duly authorized so to do, the day and year first above written.

Principal:

\_\_\_\_\_

By \_\_\_\_\_  
Title

ATTEST:

\_\_\_\_\_

Surety:

\_\_\_\_\_

By \_\_\_\_\_  
Attorney-in-Fact

**PERFORMANCE BOND**

KNOW ALL BY THESE PRESENTS:

That \_\_\_\_\_, as Principal, and \_\_\_\_\_, a corporation organized under the laws of the State of \_\_\_\_\_ and authorized to transact business in the State of Oklahoma, as Surety, are held and firmly bound unto the City of Midwest City in the penal sum of \_\_\_\_\_ Dollars (\$\_\_\_\_\_) in lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves and each of us, our heirs, executors, administrators, trustees, successors, and assigns, jointly and severally, firmly by these presents.

DATED this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

The condition of this obligation is such that:

WHEREAS, Principal entered into a written Contract with the City of Midwest City dated \_\_\_\_\_, 2023, for:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

all in compliance with the plans and specifications therefor, made a part of said Contract and on file in the office of the City Clerk, City of Midwest City, 100 N. Midwest Boulevard, Midwest City, Oklahoma 73110.

NOW, THEREFORE, if Principal shall, in all particulars, well, truly, and faithfully perform and abide by said Contract and each and every covenant, condition, and part thereof and shall fulfill all obligations resting upon Principal by the terms of said Contract and said specifications; and if Principal shall promptly pay, or cause to be paid, all labor, materials and/or repairs and all bills for labor performed on said work, whether by subcontract or otherwise; and if Principal shall protect and save harmless the City of Midwest City from all loss, damage, and expense to life or property suffered or sustained by any person, firm, or corporation caused by Principal or his or its agents, servants, or employees in the construction of said work, or by or in consequence of any negligence, carelessness or misconduct in guarding and protecting the same, or from any act or omission of Principal or his or its agents, servants, or employees in the construction of said work, or by or in consequence of any negligence, carelessness or misconduct in guarding and protecting the same, or from any act or omission of Principal shall protect and save the City of Midwest City harmless from all suits and claims of infringement or alleged infringement or patent rights or processes, then this obligation shall be null and void, otherwise it shall be and remain in full force and effect.

It is further expressly agreed and understood by the parties hereto that no changes or alterations in said Contract and no deviations from the plan or mode of procedure herein fixed shall have the effect of releasing the sureties, or any of them, from the obligations of this Bond.

IN WITNESS WHEREOF, Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact duly authorized so to do, the day and year first above written.

Principal:

\_\_\_\_\_

By \_\_\_\_\_  
Title

ATTEST:

\_\_\_\_\_

Surety:

\_\_\_\_\_

By \_\_\_\_\_  
Attorney-in-Fact

**MAINTENANCE BOND**

KNOW ALL BY THESE PRESENTS:

That \_\_\_\_\_, as Principal, and \_\_\_\_\_, a corporation organized under the laws of the State of \_\_\_\_\_, and authorized to transact business in the State of Oklahoma, as Surety, are held and firmly bound unto the City of Midwest City in the penal sum of \_\_\_\_\_ Dollars (\$\_\_\_\_\_) in lawful money of the United States of America, said sum being equal to one hundred percent (100%) of the contract price, for the payment of which, well and truly to be made, we bind ourselves and each of us, our heirs, executors, administrators, trustees, successors, and assigns, jointly and severally, firmly by these presents.

DATED this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

The condition of this obligation is such that:

WHEREAS, Principal entered into a written Contract with the City of Midwest City dated \_\_\_\_\_, 2023, for:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

all in compliance with the plans and specifications therefor, made a part of said Contract and on file in the office of the City Clerk, City of Midwest City, 100 N. Midwest Boulevard, Midwest City, Oklahoma 73110.

NOW, THEREFORE, if Principal shall pay or cause to be paid to the City of Midwest City all damage, loss and expense which may result by reason of defective materials and/or workmanship in connection with said work occurring within ONE (1) year from and after FINAL acceptance of said project by the City of Midwest City; and if Principal shall pay or cause to be paid all labor and materials, including the prime contractor and all subcontractors; and if Principal shall save and hold the City of Midwest City harmless from all damages, loss and expense occasioned by or resulting from any failure whatsoever of Principal, then this obligation shall be null and void, otherwise to be and remain in full force and effect.

It is further expressly agreed and understood by the parties hereto that no changes or alterations in said Contract and no deviations from the plan or mode of procedure herein fixed shall have the effect of releasing the sureties, or any of them, from the obligations of this Bond.

IN WITNESS WHEREOF, Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and Surety has caused

these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact duly authorized so to do, the day and year first above written.

Principal:

\_\_\_\_\_

By \_\_\_\_\_

Title

ATTEST:

\_\_\_\_\_

Surety:

\_\_\_\_\_

By \_\_\_\_\_

Attorney-in-Fact

Approved as to form this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

\_\_\_\_\_

City Attorney

**BID**

Proposal of \_\_\_\_\_  
\_\_\_\_\_, (hereinafter called BIDDER"),  
organized and existing under the laws of the State of \_\_\_\_\_  
doing business as \* \_\_\_\_\_

To the **CITY OF MIDWEST CITY** (hereinafter called "CITY").

In compliance with your Advertisement for Bids, BIDDER hereby proposes to perform all work for the construction of the following:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

in strict accordance with the CONTRACT DOCUMENTS, within the time set forth therein, and at the prices stated below.

By submission of this BID, each BIDDER certifies, and in the case of joint BID each party thereto certifies as to his own organization, that this BID has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this BID with any other BIDDER or with any competitor.

BIDDER hereby agrees to commence work under the contract documents on or before a date to be specified in the NOTICE TO PROCEED and to substantially complete the PROJECT within 210 calendar days after the Notice to Proceed and fully complete the PROJECT within 270 calendar days after the Notice to Proceed. BIDDER further agrees to pay as liquidated damages the sum of One Hundred Dollars (\$100.00) per day for each consecutive calendar day thereafter as provided in Section 14 of the General Conditions.

BIDDER acknowledges receipt of the following ADDENDUM:

\_\_\_\_\_  
\_\_\_\_\_  
**\* Insert "a corporation," "a partnership" or "an individual" as applicable.**

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS for the unit prices or lump sum as indicated on the detailed bid form. The CITY shall have the option to deduct any or all of the bid items at the unit cost or lump sum provided by the BIDDER.

BASE BID TOTAL (from DBF-1) \$ \_\_\_\_\_

\_\_\_\_\_  
(Total dollars written)

Respectfully submitted:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Address

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

\_\_\_\_\_  
License Number (if applicable)

(SEAL - If Bid is by a Corporation)

ATTEST: \_\_\_\_\_



**DETAILED BID FORM**

**NORTH SIDE SANITARY SEWER PROJECT**

Detailed bids shown below shall reflect all related project costs including, but not limited to, equipment, materials, labor, overhead and profit for installation and construction of each item per the drawings and specifications. Contractor is responsible for verifying quantities. See Appendix I to the Instructions to Bidders for directions and a sample Detailed Bid Form.

<b><u>Pay Item</u></b>	<b><u>Estimated Quantity</u></b>	<b><u>Unit</u></b>	<b><u>Item</u></b>	<b><u>Unit Price</u></b>	<b><u>Item Total</u></b>
1.	671	Linear Foot	4-inch C-900 Fusible PVC (DR 18) Sanitary Sewer Force Main with Fittings (Open Cut)	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
2.	620	Linear Foot	4-inch Fusible PVC (DR 18) Sanitary Sewer Force Main with 8-inch C-900 Fusible PVC (DR 18) Encasement (Horizontal Directional Drill)	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
3.	385	Linear Foot	8-inch PVC (SDR 26) Gravity Sewer Main (Open Cut)	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
4.	3	Each	4' Dia. Precast Sanitary Sewer Manhole	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
5.	1	Lump Sum	Connection to JB-1	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
6.	1	Lump Sum	175 GPM Firm Capacity Lift Station (Except for Pumps) with Valve, Meter Vault and Site Work	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
7.	3	Each	Submersible Pump	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					
8.	1	Lump Sum	Lift Station Electrical and Instrumentation (Including Generator and Electrical Building)	Dollars \$ _____	\$ _____
<i>(Dollars per unit written)</i>					

<u>Pay Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Item</u>	<u>Unit Price</u>	<u>Item Total</u>
9.	3	Each	Utility Dome Marker		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
10.	1	Lump Sum	Tracer Wire and Tracer Wire Test Stations		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
11.	1	Lump sum	Sediment and Erosion Control		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
12.	2,400	Square Yard	12' Wide Flexible Base Roadway with Lime Stabilization		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
13.	1	Lump sum	Seeding		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
14.	1,700	Linear Foot	Utility Location and Support		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
15.	1,700	Linear Foot	Trench Safety		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
16.	1	Lump Sum	Testing		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
17.	1	Lump Sum	Construction Survey		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					
18.	1	Lump Sum	Stormwater Pollution Prevention Plan Documentation and Management		
				Dollars	\$ _____ \$ _____
<i>(Dollars per unit written)</i>					

<u>Pay Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Item</u>	<u>Unit Price</u>	<u>Item Total</u>
19.	1	Lump Sum	Early Completion Incentive		
<u>Forty-two Thousand Five Hundred Dollars and No Cents</u>				\$ 42,500	\$ 42,500
<i>(Dollars per unit written)</i>					
20.	1	Lump Sum	Mobilization and Demobilization (5%)		
_____ Dollars				\$ _____	\$ _____
<i>(Dollars per unit written)</i>					

**BASE BID SUBTOTAL (Sum of ITEMS 1-20)**

\_\_\_\_\_ Dollars \$ \_\_\_\_\_  
*(Dollars per unit written)*

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**NONCOLLUSION AFFIDAVIT  
THIS AFFIDAVIT MUST ACCOMPANY THE BID**

City of Midwest City, Oklahoma

I, \_\_\_\_\_  
Owner, Partner, Officer of Firm

\_\_\_\_\_  
Company Name, City and State

being first duly sworn upon oath, state: I, the Company, its officers or employees, have not been party to any agreement or collusion among bidders, prospective bidders, architects or any other persons, or any other companies, in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding or otherwise on this project for:

**NORTH SIDE UTILITIES SANITARY SEWER PROEJCT**

for the City of Midwest City.

**Bids will be opened on September 5, 2023, at 2:00 PM.**

\_\_\_\_\_  
Firm Name

\_\_\_\_\_  
Signature and Title

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

\_\_\_\_\_  
Notary Public

My Commission Expires:  
\_\_\_\_\_

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**CERTIFICATION OF PRE-BID SITE INSPECTION**

I, \_\_\_\_\_,

representing

\_\_\_\_\_, certify that on the \_\_\_\_ day of \_\_\_\_\_, 2023, I inspected the project site located in Midwest City. I am thoroughly familiar and aware of all conditions at the site and problems that may be encountered during performance of the referenced project:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

BY: \_\_\_\_\_  
Name

TITLE: \_\_\_\_\_

***All bidders must inspect the project work site prior to submitting a bid. Therefore, a mandatory pre-bid conference is scheduled as specified in the Notice to Bidders.***

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**BID BOND**

KNOW ALL PEOPLE BY THESE PRESENTS, that we, the undersigned,  
\_\_\_\_\_, as Principal, and \_\_\_\_\_, as  
Surety, are hereby held and firmly bound unto the City of Midwest City in the penal sum  
of \_\_\_\_\_ for the payment of which, well and truly to be made, we  
hereby jointly and severally bind ourselves, our successors and assigns.  
Signed this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

The condition of the above obligation is such that whereas the Principal has submitted to  
the City of Midwest City a certain Bid, attached hereto and hereby made a part hereof to  
enter into a contract in writing, for the:

**NORTH SIDE UTILITIIES SANITARY SEWER PROJECT**

NOW, THEREFORE,

(a) If said Bid shall be rejected or, in the alternate,  
(b) If said Bid shall be accepted and the Principal shall execute and deliver a  
contract in the form of contract attached hereto (properly completed in accordance with  
said Bid) and shall furnish a bond for his faithful performance of said contract, and for the  
payment of all persons performing labor or furnishing materials in connection therewith,  
and shall in all other respects perform the agreement created by the acceptance of said  
Bid, then this obligation shall be void, otherwise the same shall remain in force and effect.  
It is expressly understood and agreed that the liability of the Surety for any and all claims  
hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said  
Surety and its bond shall be in no way impaired or affected by any extension of the time  
within which the City may accept such bid; and said Surety does hereby waive notice of  
any extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunder set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

\_\_\_\_\_  
Principal

\_\_\_\_\_  
Surety

By: \_\_\_\_\_

**BUSINESS RELATIONSHIPS AFFIDAVIT  
THIS AFFIDAVIT MUST ACCOMPANY THE BID**

STATE OF \_\_\_\_\_ )  
                                                      )SS

COUNTY OF \_\_\_\_\_ )

\_\_\_\_\_, of lawful age, being first duly sworn, on oath says that (s)he is the agent authorized by the bidder to submit the attached bid. Affiant further states that the nature of any partnership, joint venture or other business relationship presently in affect or which existed within one (1) year prior to the date of this statement with the architect, engineer or other party to the project is as follows:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Affiant further states that any such business relationship presently in affect or which existed within one (1) year prior to the date of this statement between any officer or director of the bidding company and any officer or director of the architectural or engineering firm or other party to the project is as follows:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Affiant further states that the names of all persons having any such business relationships and the positions they hold with their respective companies or firms are as follows:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(If none of the business relationships hereinabove mentioned exist, affiant should so state.)

\_\_\_\_\_

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

\_\_\_\_\_  
Notary Public  
My Commission Expires:

\_\_\_\_\_

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## Contractor Certification

Contractor certifies and warrants that it will comply with the Immigration Laws of the United States, including but not limited to 8 USC 1324(a), which makes it unlawful for an employer to hire or continue to employ an illegal or undocumented alien *knowing* the alien is or has become unauthorized with respect to such employment, or to fail to comply with the I-9 requirements. Contractor further agrees to comply with the Oklahoma Taxpayer and Citizen Protection Act of 2007. Contractor will not knowingly employ or knowingly allow any of its Subcontractors to employ any illegal or undocumented aliens to perform any work in connection with services performed for the City of Midwest City. After July 1, 2008, Contractor and its Subcontractors will verify information on all new employees on the Status Verification System operated by the U.S. Government.

Contractor will retain and make available for inspection by the City, upon reasonable notice, a completed I-9 Employment Eligibility Verification Form for each person that contractor directly employs to perform services for the City. If Contractor, or any of its Subcontractors, receives *actual knowledge* of the unauthorized status of one of its employees engaged in providing services to the City, then Contractor or Subcontractor will remove that employee from the project, and shall require each Sub-contractor to act in a similar fashion with respect to such Sub-contractor's employees. Contractor agrees to have a provision in its subcontracts stating that each Sub-contractor will have the same duties and responsibilities with regard to its employees that the Contractor has certified in this paragraph.

Signed under penalty of perjury on \_\_\_\_\_, 2023.

\_\_\_\_\_  
Contractor

By: \_\_\_\_\_  
Owner or Authorized Officer

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**STATEMENT OF BIDDER'S QUALIFICATIONS**  
(Site Preparation Contractor)

All questions must be answered. All responses must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate sheets. The Bidder may submit any additional information.

1. Name of Bidder:  

---
2. Permanent main office address:  

---
3. When organized:  

---
4. If a corporation, where incorporated:  

---
5. How many years have you been engaged in the contracting business under your present firm or trade name:  

---
6. Contracts on hand (Schedule these, showing amount of each contract and the appropriate anticipated dates of completion):  

---
7. General character of work performed by your company:  

---
8. Have you ever failed to complete any work awarded to you?  

---
9. Have you ever defaulted on a contract?  

---
10. List the more important projects recently completed by your company, stating the approximate cost for each and the month and year completed.  

---
11. List your major equipment available for this contract  

---
12. Experience in construction work similar in scope to this project:  

---
13. Background and experience of the principal members of your organization, including officers:  

---

14. Credit available:

\$ \_\_\_\_\_

15. Give bank reference:

\_\_\_\_\_

16. Will you, upon request by the City of Midwest City, provide a detailed financial statement and furnish other information that may be requested within ten (10) working days from the date of the request?

\_\_\_\_\_

17. The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the City of Midwest City in verification of the recitals comprising this Statement of Bidder's Qualifications.

DATED this \_\_\_\_\_ day of \_\_\_\_\_, 2022.

\_\_\_\_\_  
(Name of Bidder)

By: \_\_\_\_\_

Title: \_\_\_\_\_

STATE OF \_\_\_\_\_ )  
 ) ss  
COUNTY OF \_\_\_\_\_ )

\_\_\_\_\_, being duly sworn, states that

he/she is the \_\_\_\_\_  
(Name of Organization)

of

\_\_\_\_\_  
(Title)

and that the answers to the foregoing questions and all statements therein contained are true and correct.

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 2023.

\_\_\_\_\_  
Notary Public

My commission expires: \_\_\_\_\_

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**INSTRUCTIONS TO BIDDERS  
APPENDIX 1  
INSTRUCTIONS FOR COMPLETION OF THE DETAILED BID FORM**

Detailed Bid Forms are included in the Bidding Documents when projects are bid all or partially on a unit cost basis. Where a Detailed Bid Form is provided, Bidder is to enter the cost per unit in words and in numerals and then enter the total cost of the item (unit cost x estimated quantity) in the right hand column under "Item Total".

The Total of the Item Total Column should be entered at the bottom of the Detailed Bid Form and on the "Amount Bid" line on the Bid Form. Bidders should check to insure that the total of the Detailed Bid Form is entered correctly on the Bid Form. In cases of conflict between words and numerals, the words will govern. In cases of conflict between the amount on the Bid Form and the amount on the Detailed Bid Form, the amount on the Detailed Bid Form will govern.

There may be a Detailed Bid Form for one or more of any Alternates. If a Detailed Bid Form is provided for an Alternate, it should be completed in the same manner as the Form for the Base Bid.

An example of a correctly completed Detailed Bid Form is provided below.

**DETAILED BID FORM ITEMS**

PROJECT NO. \_\_\_\_\_

<u>Pay Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Item</u>	<u>Unit Price</u>	<u>Item Total</u>
1.	45	S.Y.	6" P.C. Concrete		
<u>Fifteen and no/100</u> <i>(Dollars per unit written)</i>				Dollars	\$ <u>15.00</u> \$ <u>675.00</u>
2.	70	L.F.	6" Integral Curb		
<u>One and 50/100</u> <i>(Dollars per unit written)</i>				Dollars	\$ <u>1.50</u> \$ <u>105.00</u>
3.	56	L.F.	6" Curb Removal		
<del>Two and 13/100</del> <u>Three and no/100 MC</u> <i>(Dollars per unit written)</i>				Dollars	\$ <del>2.13</del> <sup>3.00 MC</sup> \$ <del>119.28</del> <sup>168.00 MC</sup>
4.	1	L.S.	Plug Existing 42" R.C.P. (3 pts.)		
<u>Three Hundred and no/100</u> <i>(Dollars per unit written)</i>				Dollars	\$ <u>300.00</u> \$ <u>300.00</u>
5.	45	L.F.	24" R.C.P.		
<u>Thirty and no/100</u> <i>(Dollars per unit written)</i>				Dollars	\$ <u>30.00</u> \$ <u>1,350.00</u>

APX-1

TOTAL                    \$ 2,598.00 MC  
~~2,549.28~~



**MIDWEST CITY**

**NORTH SIDE UTILITIES  
SANITARY SEWER  
PROJECT**

**Matt Dukes, MAYOR**

**CITY COUNCIL MEMBERS**

**WARD 1 – Susan Eads**

**WARD 2 – Pat Byrne**

**WARD 3 –**

**WARD 4 – Sean Reed**

**WARD 5 – Sara Bana**

**WARD 6 – Rick Favors**

**CONTRACTOR'S NAME**  
**CONTRACTOR'S MAILING ADDRESS**  
**CONTRACTOR'S MAIN OFFICE PHONE NUMBER**

***Sample Project Sign***

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**SECTION 01 10 39**  
**INTERNET-BASED CONSTRUCTION MANAGEMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The Engineer will subscribe to an Internet-Based Construction Management system specific for this project. The System will be managed by the Engineer.
- B. The project website will provide server space and secured access to staff members representing the Owner, Engineer, and Contractor. Each user will have a separate log-in name and password to access the website.
- C. Contract management related documents will be submitted, tracked, responded to, and made available to the Owner, Engineer, and Contractor over the Internet.

**1.2 ALLOWANCE (NOT USED)**

**1.3 REQUIREMENTS**

- A. The Contractor will be required to make all submittals in electronic format. The required format will be discussed at the pre-construction meeting. The software product to be chosen will support multiple file formats and provide viewing and markup capability.
- B. The website includes a secured document management system for storing and making available to the Project team the following:
  - 1. Ability to store files and correspondence.
  - 2. Latest drawings and specifications.
  - 3. Project progress photos.
- C. The website will include the following database driven applications. The system is designed to inform team members regarding new or updated documents and automatic task assignment and overdue notifications. The following items shall be entered, submitted, tracked, and responded to on-line.
  - 1. Meeting Minutes
  - 2. Supplemental Instructions
  - 3. Field Reports
  - 4. RFIs (Requests For Information)
  - 5. Shop Drawings/Submittals
  - 6. PCMs (Proposed Contract Modifications)
  - 7. Change Orders
  - 8. Field Orders
  - 9. Contractor's Daily Reports
  - 10. Contractor's Storm Water Pollution Prevention Inspections
  - 11. Applications for Payment with Schedule of Values, Payment Forecast Schedules
  - 12. Construction Schedule
  - 13. CTRs (Certified Test Reports)
  - 14. Warranty Documents

#### 1.4 ARCHIVES

- A. The chosen web-based project management application is capable of archiving all files on the website periodically.
- B. All data from the website, such as RFIs, Submittals, etc. will be available in the archive.

### PART 2 - PRODUCTS

#### 2.1 SOFTWARE

- A. The specific site used by the Owner will be sent to the Contractor via e-mail with instructions on accessing the site.

### PART 3 - EXECUTION

#### 3.1 TRAINING

- A. One training session by the vendor to the team members at the beginning of the project will be provided. Additional training expenses will be borne by the Contractor.

#### 3.2 SUPPORT

- A. Software support will be available by the software vendor to all users of the project.

#### 3.3 OPERATION

- A. Contractor shall maintain a PC system on the jobsite including high-speed access to the Internet and ability to scan documents.

#### 3.4 DURATION

- A. The website will be active during construction and a minimum of 3 months past Final Completion. The Owner and Engineer will have the option to continue use of the website after completion of the project.

#### 3.5 ARCHIVES

- A. All files on the website will be archived every quarter and at the end of the Project. These archives will be made available to the Contractor for download over the Internet.

**END OF SECTION**



**SECTION 01 11 00  
SUMMARY OF WORK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Project Identification and Contact Information.
  - 2. Description of Work.
  - 3. Description of Connections
  - 4. Water for Construction
  - 5. Type of the Contract.
  - 6. Work phases.
  - 7. Work under other contracts.
  - 8. Limits of subcontractor participation.
  - 9. Products ordered in advance.
  - 10. Owner-furnished products.
  - 11. Use of premises.
  - 12. Owner's occupancy requirements.
  - 13. Work restrictions.
  - 14. Special Formats and Conventions.
  - 15. Permits.
  - 16. Other professional services.
- B. Related Sections include the following:
  - 1. Division 1 Section 01 12 16 "Construction of Sequence Items" for requirements for the construction sequence of various work elements.

**1.2 PROJECT IDENTIFICATION AND CONTACT INFORMATION**

- A. Project Identification:
  - 1. North Side Utilities Sanitary Sewer Project
- B. Project Number:
  - 1. Plummer Project No. 3435-003-01
- C. Project Location:
  - 1. Midwest City Water Resources Recovery Facility (7420 NE 36th St, Oklahoma City, OK 73141) and adjacent parcels
- D. Owner: City of Midwest City, Oklahoma
  - 1. Representative: Brandon Bundy, P.E.
  - 2. Address: 100 N Midwest Blvd, Midwest City, OK 73110.
  - 3. Telephone: 405-739-1213
- E. Engineer: Plummer Associates, Inc.
  - 1. Contact: Alan Swartz, P.E.

2. Address: 531 Couch Drive, Suite 200, Oklahoma City, Oklahoma 73102
3. Telephone: 405-440-2725

### 1.3 DESCRIPTION OF WORK

The Work, under this Contract, consist of construction of approximately 1,291 linear feet of 4-inch sanitary force main and approximately 385 LF of 8-inch gravity sewer main. Additionally, it will include the construction of a 175 gpm firm capacity lift station, including 12' diameter polymer concrete wet well, 15'x7' precast concrete meter box, three submersible solids-handling pumps, natural gas generator, electrical building and all related site improvements.

- A. The Project consists of the Work in the Plans and Specifications.
- B. The construction Work to be executed in the field will be based on Conformed Drawings and Specifications, which will be prepared by the Engineer based on the Work included in the Final Plans and Specifications.
- C. Unless otherwise specified, Contractor shall provide the following:
  1. Temporary facilities and controls as specified in SECTION 01 32 39 CONTRACTOR REQUIREMENTS.
  2. Provide quality control, material testing, field testing, and related services in accordance with requirements of each Specification Section.
  3. Provide quality assurance and control services in accordance with requirements in each Specification Section. Owner provided quality assurance and quality control services would be an overview of the Work during construction.
  4. Provide training of Owner's operation and maintenance personnel in accordance with SECTION 01 78 23 OPERATION AND MAINTENANCE DATA.
  5. Field surveying required for support of construction operations. Applicable permits, licenses and jurisdictional inspections, certificate of occupancy, and related work as necessary for Owner to assume operation of facility.

### 1.4 TYPE OF CONTRACT

- A. Project will be constructed under a single prime contact.

### 1.5 USE OF PREMISES

- A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.
- B. Use of Site: Limit use of premises to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  1. Limits: Confine construction operations to areas where work is permitted.
  2. Owner Occupancy: Allow for Owner occupancy of Project site.
  3. Driveways and Entrances: Keep driveways and entrances serving facilities clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
- C. Use of Existing Facilities: Maintain existing building, structures and/or site elements in a working condition throughout construction period. Repair damage caused by construction operations. Protect any facility and their occupants during construction period.

### 1.6 OWNER'S OCCUPANCY REQUIREMENTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.
  - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
  - 2. Provide not less than 72-hours' notice to Owner of activities that will affect Owner's operations.
  
- B. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of Project, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
  - 1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before Owner occupancy.
  - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
  - 3. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of facilities.
  - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

## 1.7 WORK RESTRICTIONS

- A. On-Site Work Hours: Work shall be generally performed at the site during normal business working hours of 8:00 a.m. to 5:00 p.m., Monday through Friday, except otherwise indicated.
  - 1. Weekend Hours: 7:00 a.m. to 4:00 p.m., with written notification to OWNER 72 hours in advance.
  - 2. Early Morning Hours: Contractor shall minimize early morning hours or late evening hours of work and shall comply with local requirements of authorities having jurisdiction for restrictions on noisy work. A variance shall be obtained before proceeding with the work.
  - 3. Hours for Utility Shutdowns: Tuesday through Thursday, no utility shutdown on Monday or Friday.
  
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by OWNER or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify ENGINEER not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without ENGINEER'S written permission.

## 1.8 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI "Master Format" numbering system.
  - 1. Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred, as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
  - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
  - 3. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 4. Additional meaning of language used may be found in the General Conditions Article "Defined Terms and Terminology."

#### 1.9 PERMITS

- A. Attention is directed to the requirements of the General Conditions regarding obtaining permits. The Contractor shall obtain and pay for all applicable permits in connection with the Work including a stormwater discharge permit. The Bid Prices shall include the costs for obtaining all required permits, as well as performing the work in accordance with the permit requirements.

#### 1.10 OTHER PROFESSIONAL SERVICES

- A. Other Professional Services: Engineer(s) or engineering firms which may be retained by the Contractor his subcontractors or vendors to fulfill engineering requirements of the Project during the construction phase.
- B. When professional engineering services are required during the course of the Project, the Contractor shall comply with the requirements of Chapter 475 of the Oklahoma Statutes and shall select and award on the basis of demonstrated competence and qualifications to perform the services for a fair and reasonable price and shall not select services or award contracts on the basis of competitive bidding.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**

**SECTION 01 12 16**  
**CONSTRUCTION OF SEQUENCE ITEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 CONSTRUCTION SEQUENCE FOR SPECIFIC ITEMS**

- A. Any operational shutdowns must be coordinated at least five days in advance.
- B. Dewatering, demolition, and repairs must be completed within the approved shutdown window.
- C. The Owner shall define the available shutdown window at the time of the repair.
- D. All Materials shall be on-site, verified, and ready for installation two days prior to the scheduled shutdown. Failure to have all materials at the site will result in cancelling of the planned shutdown at no cost to the Owner.

**1.3 COORDINATION WITH OTHER CONTRACTORS AND PROJECTS**

- A. Work by other contractors at Water Resources Recovery Facility and adjacent parcels may be in progress during this Project.
- B. Schedule construction operations in sequence required obtaining the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- C. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
- D. Make adequate provisions to accommodate items scheduled for later installation.
- E. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

**1.4 GENERAL**

- A. The conveyance and operations necessary to meet critical drinking water requirements are of higher priority than other construction activities. Schedules of connections, renovations and modifications required during operation shall be submitted to the Owner for approval, and all such items shall be coordinated with the Owner. These schedules shall permit full and normal treatment and conveyance of potable water.
- B. The Contractor shall prepare and submit a project schedule within 30 days of beginning work, outlining the schedule and time requirements for each item involving major valves and appurtenances, conveyance system and tunnels. No payment shall be made until these items are received.
- C. The Contractor shall notify the Owner at least 14 days in advance and again 3 days prior to beginning work on a particular area and prior to any shutdowns, and coordinate with the Owner the specific items to be isolated and duration for each. The Contractor shall submit a workplan with each Shutdown request. The workplan shall include a list of materials,

personnel, equipment, items needed from the Owner, and isolation needs. Obtain written approval from the Owner prior to each shutdown. High flow conditions or equipment outages may require the rescheduling of an approved shutdown. Any cost associated with rescheduling will be subsidiary to Project.

- D. After startup, the Contractor shall not operate any valves or equipment in the plant unless directed to do so in writing by the Owner.
- E. Prior to beginning work, the Contractor shall have on-site all materials, equipment, and personnel necessary to complete the work in the time scheduled. The Contractor shall also perform all possible tasks to the most complete state possible prior to shutdowns. All exposed bolts and nuts on valves or fittings which are to be disassembled shall be removed and replaced one at a time prior to shutdown to assure as timely progress as possible.
- F. Failure of the Contractor to properly plan and perform the work in the prescribed manner may result in partially treated water. In this case, the Contractor may be liable for payment of fines, fees or other charges imposed upon the Owner by state or federal regulatory agencies, and all other costs associated with the partially treated water.
- G. Access to all plant facilities must be maintained at all times.
- H. Existing plugged pipelines, in which water has been standing, shall have to be cleaned of debris and disinfected prior to connecting to a new pipeline.
- I. The Contractor shall coordinate and schedule each task necessary to complete all work within the time allowed for the project. Specific connection coordination, shutdown, and out of service (downtime) limitations are further described in Paragraph 1.5 and 1.6.
- J. The sequencing may require the Contractor to perform work such as installing temporary or permanent plugs and/or diversion facilities in structures that are online. The specifics related to flow diversion and temporary plugging means and methods are the responsibility of the Contractor, however, the Contractor's proposed work operations and schedules shall be submitted to the Owner for review.
- K. Plant Piping Interconnections Requirements. All testing of pipes to be connected shall be completed and test reports furnished to the Engineer prior to making connections.
  - 1. Drain system connections should generally not require prior notification to proceed unless the existing pipe must be temporarily plugged or blocked for the connection.
  - 2. Plant water and potable water connections require advance notification and concurrence from the Owner prior to isolating or shutting down the system for connection. Potable pipes should be flushed and pressure tested prior to connection and disinfected prior to the connection. Contractor shall coordinate these items.
  - 3. Reduce the number of shutdowns required for piping systems by combining as many connections at the same time as feasible.
  - 4. Plant process piping connections are critical and shall be fully coordinated and shall be expedited and done in a continuous manner upon initiation. These pipes generally do not have isolation valves or parallel pipes and require shutting down the treatment process for connection. Time shall be allowed for shutting down the process and dewatering the existing pipe in addition to the actual connection time. Contractor shall provide all equipment, tools and labor to dewater the pipes for connections. This process water shall be contained in the facilities and not allowed to discharge over the ground or to the surface drainage systems. Generally, the time period allowed for these connections will not exceed four hours total unless approved in writing by the

Owner.

5. All filtered water, finished water, and in plant potable water piping shall be cleaned, disinfected, and tested prior to placing into service. Contractor shall provide taps, flushing, and blow-off connections to flush and disinfect each pipe section and treatment unit.

#### 1.5 OPERATIONS AND MAINTENANCE ACCESS

- A. Provide safe, continuous access to process control equipment for pipeline operations personnel.
- B. Provide access on 1-hour advance notice to process control equipment for pipeline maintenance personnel and associated maintenance equipment.

#### 1.6 UTILITIES

- A. Provide advance notice to and utilize services of One Call for location and marking of underground utilities operated by utility agencies other than the Owner.
- B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.
- C. New yard utilities were designed using existing facility drawings.
  1. Field verification of utilities locations was not performed during design.
  2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
  3. Pipe alignments as indicated on the Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**

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**SECTION 01 29 00  
MEASUREMENT AND PAYMENT**

**PART 1 - GENERAL**

The "Bid Price" for each item, as set forth in the Proposal, shall include the furnishing of all labor, tools, materials, machinery, appliances, plant and equipment appurtenant to and necessary for the construction and completion in a first class, workmanlike manner of all work as herein specified in strict accordance with these Specifications and accompanying Plans. The "Bid Price" shall include any amount or class of excavation, backfilling, dewatering, bypass pumping, drainage, sheeting, shoring and bracing, disposal of any and all surplus materials, protection of all overhead, surface or underground structures; removal and replacement of any poles, conduits, pipelines, appurtenances and connections, clean up, overhead expense, bond, public liability and compensation and property damage insurance, patent fees, and royalties, risk due to the elements, and profits, unless otherwise specified.

The Bid price shall also include all other incidentals not specifically mentioned above that may be required to fully construct each and every item complete in place in accordance with the true intent and meaning of the Specifications and accompanying Plans.

The Contractor shall take all measures necessary to protect existing structures, lawns, trees, shrubbery, etc., on the areas adjacent to the work which is not necessary to cut as a part of the construction, and if damaged, shall replace them in as good condition or better than previously existed at his own cost and expense without additional compensation from the Owner.

The Contractor shall protect and attempt to save all trees noted in the Plans and as instructed by the Owner without additional compensation by the Owner.

Listed below are descriptions of items as listed in the Proposal and the manner in which payment shall be awarded for each. If there is not a specific measurement and/or payment section, paragraph or item associated with each Technical Specification contained in this Contract Document, then the following descriptions shall be used to describe measurement and payment. If there is not a bid item provided for work identified on plans or in specifications, it shall be understood to be subsidiary to construction, measurement, and payment of one of the following Bid Items provided below.

**PART 2 - BASE BID ITEMS**

**BID ITEM 1 – 4-INCH C-900 FUSIBLE PVC (DR 18) SANITARY SEWER FORCE MAIN WITH FITTINGS (OPEN CUT)**

The unit price bid per linear foot shall include furnishing all labor, equipment, and materials necessary to install, BY OPEN CUT, the 4-inch C-900 FUSIBLE PVC DR 18 pipe as shown in the plans, standard details, and described in the specifications. The cost of all pipe, pipe fusion, fittings, installation, site clearing, top soil stripping and stock piling, trench excavation, pipe embedment, warning tape, backfill, compaction, hydrostatic testing, topsoil redistribution, ground water control planning and dewatering activities, and all other incidental items necessary for a complete and workable installation are included in this pay item. Tracer wire and the associated test stations are paid for under Bid Item #10. Conflicting utility support and/or relocation is paid for under Bid Item #14.

**BID ITEM 2 – 4-INCH FUSIBLE C-900 PVC (DR 18) SANITARY SEWER PIPE WITH 8-INCH C-900 (DR 18) FUSIBLE PVC ENCASEMENT (HORIZONTAL DIRECTIONAL DRILL)**

The unit price bid per linear foot shall include furnishing all labor, equipment, and materials necessary to install, BY HORIZONTAL DIRECTIONAL DRILL, the 4-inch C-900 FUSIBLE PVC (DR 18) pipe with 8-inch C-900 FUSIBLE PVC (DR 18) encasement as shown in the plans, standard details, and described in the specifications. The cost of top soil stripping and stock piling, insertion and extraction pit excavation, all necessary dewatering activities, horizontal directional drilling, fusible PVC casing fusion and installation, carrier pipe fusion and installation, all necessary fittings, casing spacers, vents, end seals, embedment, backfill, compaction, topsoil redistribution, hydrostatic testing, and all other incidental items necessary for a complete and workable installation are included in this pay item. Tracer wire and the associated test stations are paid for under Bid Item #10. Conflicting utility support and/or relocation is paid for under Bid Item #14.

**BID ITEM 3 – 8-INCH PVC (SDR 26) GRAVITY SEWER MAIN (OPEN CUT)**

The unit price bid per linear foot shall include furnishing all labor, equipment, and materials necessary to install, BY OPEN CUT, the 8-inch SDR 26 PVC pipe as shown in the plans, standard details, and described in the specifications. The cost of all pipe, fittings, trench excavation, pipe embedment, warning tape, backfill, compaction, leakage testing, site clearing, top soil stripping and stock piling, topsoil redistribution, ground water control planning and dewatering activities, closure pieces, removal of approximately 20 linear feet of 24-inch sanitary sewer main adjacent to JB-1, and all other incidental items necessary for a complete and workable installation are included in this pay item. Tracer wire and the associated test stations are paid for under Bid Item #10. Conflicting utility support and/or relocation is paid for under Bid Item #14.

**BID ITEM 4 – 4' DIA. PRECAST SANITARY SEWER MANHOLE**

The unit price bid item per each shall include furnishing all labor, equipment, and materials necessary to install the 4' diameter precast sanitary sewer manhole as shown at the locations and at the depths as shown and described in the plans, standard details, and specifications. The cost of precast manhole, grade rings, rim and bolt down cover, crushed rock foundation, excavation, dewatering, backfill, compaction, grading, accessories, required coatings and lining, leakage testing, connection to the associated gravity of force main piping, site restoration, sodding and clean up, and all other incidental items necessary for a complete and workable installation are included in this pay item. Tracer wire test stations are paid for under Bid Item #10.

**BID ITEM 5 – CONNECTION TO JB-1**

The lump sum price bid for connection to Junction Box #1 (JB-1) shall include furnishing all labor, equipment, and materials necessary to connect the proposed 8-inch PVC (SDR-26) Gravity Sewer Main to JB-1 as shown in the plans, standard details, and described in the specifications. The cost of topsoil stripping, excavation, dewatering, coring the external wall of JB-1, installation of wall fittings and gravity sewer main, grouting around the wall fitting with non-shrink grout, installation of the concrete pipe support including dowels, epoxy, reinforcing steel, formwork, and concrete, backfill, compaction, grading, restoration and clean-up, and all other incidental items necessary for a complete and workable installation are included in this pay item.

## **BID ITEM 6 – 175 GPM FIRM CAPACITY LIFT STATION (EXCEPT FOR PUMPS) WITH VALVE, METER VAULT, AND SITE WORK**

The lump sum price bid for furnishing all labor, equipment, and materials necessary to install the 175 gallon per minute (GPM) firm capacity lift station as shown in the plans, standard details, and described in the specifications. The cost of excavation; dewatering; crushed stone base for the wet well and the valve vault; 10-foot diameter concrete polymer wet well with dual 36"x48" double leaf hatches and associated grouting of the floor; 15'x7' precast concrete vault with dual 48"x48" double leaf hatches; 4-inch stainless steel vent, 3-inch and 4-inch epoxy coated ductile iron discharge piping, epoxy coated fittings, valves, flow meter, pipe hangers and supports, associated wall penetrations and appurtenances; wet well wizard system including blower, air diffuser, associated stainless steel piping, supports, fittings, EPDM air hose and all associated appurtenances; 6-inch sump floor drain and piping; restrained connection between ductile iron piping and HDPE force main; native backfill at lift station site; controlled low-strength material (CLSM) backfill at lift station site; fine grading of the site; geotextile fabric; lime stabilization at lift station site; compaction; gravel at lift station site; security fencing including fence, sliding gate, pedestrian gate and all associated appurtenances; restoration and clean-up; and all other incidental items necessary for a complete and workable installation are included in this pay item.

Items not included in this Bid Item shall include the submersible pumps (including all incidental items) and electrical and instrumentation (including generator, electrical building, foundations, and all other incidental items).

## **BID ITEM 7 – SUBMERSIBLE PUMP**

The unit price bid item per each shall include furnishing all labor, equipment, and materials necessary to install the submersible pump as shown in the plans, standard details, and described in the specifications. The cost of the pump, installation, cables, railing, support base elbow, anchors, bolts, nuts and all other incidental items necessary for a complete and workable installation are included in this pay item.

## **BID ITEM 8 – LIFT STATION ELECTRICAL AND INSTRUMENTATION (INCLUDING GENERATOR AND ELECTRICAL BUILDING)**

The lump sum bid item shall include furnishing all labor, equipment, and materials necessary for the electrical and instrumentation, generator, and electrical building as shown in the plans, standard details, and described in the specifications. The cost of electrical and instrumentation panels; communication; programming; starters; wiring; supports; raceways; duct banks; conduit; equipment, grounding; natural gas generator; transfer switch; fuel piping; meter; utility coordination; electrical power drop; concrete pads including subgrade preparation; electrical building; excavation; backfill; site restoration; appurtenances; and all other incidental items necessary for a complete and workable installation are included in this item.

## **BID ITEM 9 – UTILITY DOME MARKER**

The unit price bid item per each shall include furnishing all labor, equipment, and materials necessary for the utility dome markers as shown in the plans, standard details, and specifications. The cost of dome markers and all other incidental items necessary for a complete and workable installation are included in this item.

## **BID ITEM 10– TRACER WIRE AND TRACER WIRE TEST STATIONS**

The lump sum price bid item shall include furnishing all labor, equipment, and materials necessary to install the tracer wire and tracer wire test stations as shown in the plans, standard details, and described in the specifications. Tracer wire shall be installed the full length of the gravity and pressure piping associated with this project. The cost of the tracer wire; tracer wire test stations, connections to the utility dome markers, connections to the manholes, connection to the lift station structure and connection to JB-1 structure; connection hardware and all other appurtenances necessary for a complete and workable installation are included in this item.

## **BID ITEM 11 – SEDIMENT AND EROSION CONTROL**

The lump sum price bid shall include furnishing all labor, equipment, and materials necessary for the installation and continual maintenance of the sediment and erosion control as set forth in the Contractor's SWPPP, shown in the standard details, and described in the specifications. The cost of sediment erosion control and all other incidental items necessary for a complete and workable installation are included in this item.

## **BID ITEM 12 – 12' WIDE FLEXIBLE BASE ROADWAY WITH LIME STABILIZATION**

The unit price bid per square yard shall include furnishing all labor, equipment, and materials necessary for the 12-foot wide flexible base roadway with lime stabilization as shown in the plans, shown in the standard details, and described in the specifications. The cost of grading, subgrade compaction and preparation, lime stabilization, geotextile fabric, flexible base roadway, concrete drive and approach, gate and all other incidental items necessary for a complete and workable installation are included in this item.

## **BID ITEM 13 – SEEDING**

The lump sum bid item shall include furnishing all labor, equipment, and materials necessary for seeding as shown in the plans, standard details, and specifications. The cost of final grading, seed mixture application and maintenance for ALL disturbed areas, fertilizer, water, pulp, maintenance watering, and all other incidental items necessary for a complete and workable installation are included in this item.

## **BID ITEM 14 – UTILITY LOCATION AND SUPPORT**

The unit price bid per linear foot shall include furnishing all labor, equipment, and materials necessary to locate and support all existing private, public and franchise utilities that will be crossed or encountered on this project as shown in the plans, standard details, and as described in the specifications. The cost of excavation, recording the horizontal and vertical utility location with GPS survey equipment, establishment of size and material, temporary support of the utility, flowable fill, embedment, compaction, backfill and all other incidental items necessary for a complete and workable installation are included in this pay item. This Bid Item shall be paid per linear foot and will be measured along the centerline of the pipe.

### **BID ITEM 15 – TRENCH SAFETY**

The unit price bid per linear foot shall include furnishing all labor, equipment, and materials necessary to design, furnish, install, and maintain a trench safety system. The cost shall include the design (must be sealed by a Professional Engineer licensed in the State of Oklahoma), all necessary geotechnical work, labor, all shoring (including any special shoring), sheeting, bracing and any other equipment or incidental items necessary for a complete and workable installation are included in this pay item. This Bid Item shall be paid per linear foot and will be measured along the centerline of the pipe and the outside edge of any vaults or structures.

### **BID ITEM 16 – TESTING**

The lump sum unit price bid shall be measured based on the percentage of the pipeline, manholes and structures that have been installed and shall include all labor, equipment, and materials necessary for the pressure and deflection testing of the 4" diameter force main; leakage and deflection testing of the 8" diameter gravity sanitary sewer; leakage testing of the manholes; and leakage testing of the lift station wet well as shown in the plans, standard details, and described in the specifications. The cost of all testing and all other incidental items necessary for a complete and workable installation are included in this pay item.

### **BID ITEM 17 – CONSTRUCTION SURVEY**

The lump sum unit price bid shall be measured based on the percentage of the project that has been installed. This item shall include all material, labor, and equipment to survey the project improvements in order to facilitate the creation of record drawings. The cost of mobilization, field survey, documentation, correspondence and transmittal of survey, and all other incidental items necessary to restore the ground surface are included in this item. No more than 90% of this item shall be paid until Substantial Completion.

### **BID ITEM 18 – STORMWATER POLLUTION PREVENTION PLAN DOCUMENTATION AND MANAGEMENT**

This lump sum bid item shall be measured based on the percentage of the pipeline that has been installed. This item shall include all material, labor and equipment to design, install, and maintain an approved Storm Water Pollution Prevention Plan (SWPPP), in accordance with project standard details and specifications. The SWPPP must be approved by Engineer and erosion control measures must be installed prior to any construction. This item shall include filing the Notice of Intent (NOI) and the Notice of Termination (NOT) with the Oklahoma Department of Environmental Quality (DEQ). The cost of permitting, SWPPP preparation, installation, maintenance and removal of erosion control devices, sediment handling and all other incidental items necessary to restore the ground surface are included in this item.

### **BID ITEM 19 – EARLY COMPLETION INCENTIVE**

This lump sum unit price bid item shall include an incentive of \$2,500 per calendar day offered by the City of Midwest City to the Contractor for early completion of the Project. The maximum incentive paid will not exceed \$42,500. To be considered eligible for the incentive or some portion thereof, the lift station, force main and gravity sanitary sewer lines must be installed and operational and the Project considered substantially complete and usable for its intended purpose and in accordance with the plans, standard details and as described in the specifications.

## **BID ITEM 20 – MOBILIZATION AND DEMOBILIZATION**

This per lump sum bid item shall include furnishing materials and equipment, permits and labor necessary to move all machinery and personnel required onto, and off, the job site to perform construction in accordance with the plans, standard details, and specifications. The cost of the insurance, bonds, mobilization, demobilization, and all other incidental items are included in this lump sum pay item. This item shall not exceed 5% of the total bid. No more than 90% of this item shall be paid until Substantial Completion.

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**

**SECTION 01 31 00  
PROJECT ADMINISTRATION**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Applications for Payment.
  - 2. Allowances.
  - 3. Unit Prices.
  - 4. Alternates.
  - 5. Contract Modifications.
  - 6. Execution of the Work including, but not limited to, the following:
    - a. OSHA Standards
    - b. Construction layout.
    - c. Field engineering and surveying.
    - d. General installation of products.
    - e. Progress cleaning.
    - f. Starting and adjusting.
    - g. Protection of installed construction.
    - h. Correction of the Work.
    - i. Basin dewatering and cleaning.
    - j. Workmanship.
    - k. Firearms.
    - l. Handling materials not approved.
    - m. Salvaged material.
    - n. Archeological discoveries.
    - o. Endangered species.
    - p. Blasting and burning.
    - q. Pipe closure and buoyancy of structures.
  - 7. Project Closeout

**1.3 RELATED SECTIONS**

- A. SECTION 01 11 00 – SUMMARY OF WORK
- B. SECTION 01 32 33 – PROJECT DOCUMENTATION

**1.4 APPLICATIONS FOR PAYMENT.**

- A. Schedule of Values
  - 1. Coordinate preparation of the Schedule of Values with preparation of Contractor's

## Construction Schedule

- a. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Application for Payment forms with Continuation Sheets, Submittals Schedule, and Contractor's Construction Schedule.
  - b. Submit the Schedule of Values to Engineer at earliest possible date but no later than ten (10) days before the date scheduled for submittal of initial Applications for Payment.
2. Use the Bid Form and Specification Table of Contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
- a. Include the following Project identification on the Application for Payment:
    - 1) Project name and location.
    - 2) Owner's Project Number.
    - 3) Name of Engineer.
    - 4) Engineer's project number.
    - 5) Contractor's name and address.
    - 6) Date of submittal.
    - 7) Application for Payment number.
  - b. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
  - c. Mobilization payment shall not exceed 3 percent of the total Contract amount. Payment will be made as follows:
    - 1) Payment will be authorized when Contractor commences site preparation and earthwork with equipment and materials sufficiently deployed to maintain progress of work in accordance with the construction schedule.
  - d. Include separate line items under required principal subcontracts for operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training in the amount of 5 percent of the Contract Sum.
  - e. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
  - f. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
  - g. Include accepted Schedule of Values for each schedule or portion of lump sum Work, and the unit price breakdown for Work to be paid on a unit price basis.
  - h. Include separate line item for each Change Order and Work Order Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.
  - i. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
  - j. Provide a separate line item in the Schedule of Values for each allowance. Show



line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

- k. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
  - 1) Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
- l. Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

B. Applications for payment

- 1. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
  - a. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- 2. The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
- 3. Use one of the following forms for Applications for Payment.
  - a. AIA Document G702 and AIA Document G703 Continuation Sheets
  - b. AIA Document G702/CMA and AIA Document G703 Continuation Sheets
  - c. Contractor's form, when approved by Engineer and Owner.
- 4. Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.
  - a. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
  - b. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- 5. Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
  - a. List of subcontractors.
  - b. Schedule of Values.
  - c. Contractor's Construction Schedule (preliminary if not final).
  - d. Schedule of unit prices.
  - e. Submittals Schedule (preliminary if not final).
  - f. List of Contractor's staff assignments.
  - g. List of Contractor's principal consultants.
  - h. Copies of building permits.
  - i. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

- j. Initial progress report.
  - k. Report of preconstruction conference.
  - l. Certificates of insurance and insurance policies.
6. Contractor shall submit to the Engineer for review and approval a Schedule of Values for portions of work that are lump sum bid items.
7. Payment Application Procedures:
- a. Once a month, the Contractor shall submit to the Owner's Representative one (1) draft copy of the partial pay estimate for review. Owner's Representative shall review and revise, as necessary, and then return the draft to the Contractor. Allow Owner's Representative seven (7) days minimum to check pay estimate.
  - b. Contractor shall then prepare six (6) original signed copies for the Owner's Representative signature. Provide one (1) extra original for Owner's Representative to check one more time. (Original signatures are required on all six (6) summary pages and six (6) signature pages. Photocopied signatures will not be accepted.)
  - c. One copy shall include waivers of lien and similar attachments if required. Partial pay requests shall be on forms approved by the Owner.
  - d. Contractor shall use approved Schedule of Values and Bid Schedule for pay items. Provide signature space for Contractor, Owner's Project Manager, or as designated.
  - e. Pay Estimate pages should be submitted in this order:
    - 1) Summary of Payment Estimate Values with notarized statement.
    - 2) Attachment A – Total Value of Contract Performed
    - 3) Attachment B – Extra Work on Approved Change Orders
    - 4) Attachment C – Materials on Hand
    - 5) Copies of new "materials on hand" invoices received during the current payment period placed in the order listed on Attachment C. Copies of invoices for prior periods do not need to be submitted again.
    - 6) Attachment D – Project Summary
    - 7) Signature page
  - f. After signature is obtained from the Owner's Representative, the Contractor shall submit the six (6) signed copies to the Engineer for review and forwarding to the Owner for payment.
  - g. The Engineer will review and if he approves shall mail the six (6) copies to the Owner.
  - h. Contractor should always check pay estimate remittance copies for any corrections prior to preparation of the next pay estimate. Just because the payment amount is the same as that submitted does not mean there were no errors.
  - i. Type written working copies are required.
  - j. Materials incorporated into the project are tax-exempt. Contractor is responsible for all taxes related to construction of this project.
  - k. Some of this pay estimate process may be able to be performed electronically.

8. Beginning with the second Application for Payment, each Application shall include a Contractor's Affidavit regarding discharge of payment obligations in accordance with the General Conditions.
  9. After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
    - a. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
    - b. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
  10. Submit Final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited to, the following:
    - a. Requirements of General and Supplementary Conditions for final payment.
    - b. Evidence of completion of Project closeout requirements.
    - c. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
    - d. Updated final statement, accounting for final changes to the Contract Sum.
    - e. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
    - f. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
    - g. AIA Document G707, "Consent of Surety to Final Payment."
    - h. Evidence that claims have been settled, or provide a list of claims Contractor believes are unsettled.
    - i. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
    - j. Final, liquidated damages settlement statement.
- C. Payment
1. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.
  2. Payment will not be made for the following:
    - a. Loading, hauling, and disposing of rejected material.
    - b. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
    - c. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
    - d. Material not unloaded from transporting vehicle.
    - e. Material remaining on hand after completion of work.
- D. Partial Payment for Stored Materials and Equipment
1. No partial payment will be made for materials and equipment delivered or stored unless Shop Drawings or preliminary operation and maintenance manuals are acceptable to Engineer.

2. Final Payment will be made only for products incorporated in Work; remaining products, for which partial payment have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

## 1.5 ALLOWANCES

- A. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
  1. Lump-sum allowances.
  2. Unit-cost allowances.
  3. Quantity allowances.
  4. Contingency allowances.
  5. Testing and inspecting allowances.
- C. Allowance shall include cost to Contractor of specific products and materials ordered by Owner and/or selected by Engineer under allowance and shall include taxes, freight, and delivery to Project site.
- D. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner and/or selected by Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.
- E. Selection and Purchase
  1. At the earliest practical date after award of the Contract, advise Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
  2. At Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
  3. Purchase products and systems selected by Engineer from the designated supplier.
  4. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.
- F. Contingency Allowances
  1. Use the contingency allowance only as directed by Engineer for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
  2. Contractor's overhead, profit, and related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
  3. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.
  4. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

## 1.6 UNIT PRICES

- A. Unit price is an amount proposed by bidders as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.
- B. Procedures
  - 1. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
  - 2. Refer to SECTION 01 29 00 - MEASUREMENT AND PAYMENT for work that requires establishment of unit process.
  - 3. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

## 1.7 CONTRACT MODIFICATIONS

- A. Engineer will issue Field Orders authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Proposal Requests
  - 1. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
    - a. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
    - b. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      - 1) Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      - 2) Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      - 3) Include costs of labor and supervision directly attributable to the change.
      - 4) Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  - 2. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Engineer.
    - a. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

- b. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
  - c. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
  - d. Include costs of labor and supervision directly attributable to the change.
  - e. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  - f. Comply with requirements in SECTION 01 32 33 - PROJECT DOCUMENTATION if the proposed change requires substitution of one product or system for product or system specified.
3. Proposal Request Form: Use forms provided by the Internet-Based Construction Management program.
- C. Allowance for Contract Modification
- 1. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
    - a. Include installation costs in purchase amount only where indicated as part of the allowance.
    - b. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
    - c. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
    - d. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
  - 2. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21-days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21-days after such authorization.
- D. Change Order Procedures
- 1. On Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor.

## 1.8 EXECUTION OF THE WORK

### A. Submittals

- 1. Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- 2. Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

3. Submit two copies of certified surveys signed by land surveyor.
  4. Submit two copies of final property survey showing the Work performed and record survey data.
- B. Quality Assurance
1. Land Surveyor shall be a professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

## 1.9 PROJECT CLOSEOUT

- A. This subpart includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
  2. Final cleaning.
- B. Substantial Completion
1. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
    - a. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
    - b. Advise Owner of pending insurance changeover requirements.
    - c. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
    - d. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
    - e. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
    - f. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
    - g. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
    - h. Complete startup testing of systems.
    - i. Submit test/adjust/balance records.
    - j. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
    - k. Advise Owner of changeover in heat and other utilities.
    - l. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
    - m. Complete final cleaning requirements, including touchup painting.
    - n. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
  2. Inspection: Submit a written request for inspection for Substantial Completion. On

receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, which must be completed or corrected before certificate will be issued.

- a. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
- b. Results of completed inspection will form the basis of requirements for Final Completion.

C. Final Completion

1. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
  - a. Submit a final Application for Payment.
  - b. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  - c. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  - d. Submit pest-control final inspection report and warranty, as applicable.
  - e. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videotapes.
2. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
  - a. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

D. List of Incomplete Items (Punch List)

1. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use Punch List similar to the form attached.
  - a. Organize list in sequential order as directed by Owner's Representative.
  - b. Organize items applying to each space by major element.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 ALLOWANCES

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.



- B. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

### 3.2 UNIT PRICES

- A. Not Used

### 3.3 ALTERNATES

- A. Schedule of Alternates – Not Used

### 3.4 CONTRACT MODIFICATIONS SUPPLEMENTS

- A. Forms for the following work will be provided by the Internet-Based Construction Management Program. Forms can be provided in electronic format.
  - 1. Field Change
  - 2. Proposed Contract Modification by Owner
  - 3. Contractor's Modification Request
  - 4. Change Order

### 3.5 EXECUTION OF THE WORK

- A. Examination
  - 1. Existing Conditions and Utilities: When appropriate, the existence and location of site improvements, underground and other utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
    - a. Before construction, verify the location and points of connection of utility services.
    - b. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
    - c. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  - 2. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
    - a. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
    - b. Examine rough-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
    - c. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
    - d. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

- B. Preparation

1. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
  2. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  3. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
  4. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.
- C. OSHA Standards
1. All work performed under this Contract shall meet the applicable requirements of the Occupational Safety and Health Administration (OSHA). It is the responsibility of the Contractor to become familiar with the provisions of regulations published by OSHA in the Federal Register and to perform all of the responsibilities thereunder. It is the Contractor's responsibility to see that the Project is constructed in accordance with OSHA regulations and to indemnify and save harmless the Owner from any penalties resulting from the Contractor's failure to so perform.
- D. Construction Layout
1. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
  2. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
    - a. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
    - b. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
    - c. Inform installers of lines and levels to which they must comply.
    - d. Check the location, level and plumb, of every major element as the Work progresses.
    - e. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
    - f. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
  3. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
  4. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with

control lines and levels. Level foundations and piers from two or more locations.

5. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

E. Field Engineering

1. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
2. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - a. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

F. Installation

1. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - a. Make vertical work plumb and make horizontal work level.
  - b. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - c. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
2. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
3. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
4. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
5. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
6. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
7. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - a. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
  - b. Allow for building movement, including thermal expansion and contraction.
  - c. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or

masonry. Deliver such items to Project site in time for installation.

8. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
9. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

#### G. Progress Cleaning

1. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
  - a. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - b. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 degree F.
  - c. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
2. Site: Maintain Project site free of waste materials and debris.
3. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  - a. Remove liquid spills promptly.
  - b. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
4. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
5. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
6. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
7. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
8. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
9. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

#### H. Starting and Adjusting

1. Start equipment and operating components to confirm proper operation in accordance with SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA and the following:

- a. Remove malfunctioning components, replace with new components, and retest.
  - b. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
  - c. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Manufacturer's Services: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in each Specification Section.
- I. Protection of Installed Construction
- 1. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
  - 2. Comply with manufacturers written instructions for temperature and relative humidity.
- J. Cutting and Patching
- 1. Perform cutting, fitting, and patching required to complete the Work or to:
    - a. Uncover Work to provide for installation of new Work or the correction of defective work.
    - b. Provide routine penetrations of non-structural surfaces for installation of mechanical, electrical, and plumbing Work.
    - c. Uncover Work that has been covered prior to observation by the Engineer.
  - 2. Submit written notification to the Engineer in advance of performing any cutting which affects:
    - a. Work of any other contractors or the Owner.
    - b. Structural integrity of any structure or system of the Project.
    - c. Integrity of effectiveness of weather exposed or moisture resistant structure or systems.
    - d. Efficiency, operational life, maintenance, or safety of any structure or systems.
    - e. Appearance of any structure or surfaces exposed occasionally or constantly to view.
  - 3. The notification shall include:
    - a. Identification of the Project.
    - b. Location and description of affected Work.
    - c. Reason for cutting, alteration, or excavation.
    - d. Effect on the Work of any separate contractor or Owner.
    - e. Effect on the structural or weatherproof integrity of the Project.
    - f. Description of proposed Work, including:
      - 1) Scope of cutting, patching, or alteration.
      - 2) Trades that will perform the Work.
      - 3) Products proposed for use.
      - 4) Extent of refinishing to be performed.
      - 5) Cost proposal, when applicable

- g. Alternates for cutting and patching.
  - h. Written authorization from any separate contractor whose Work would be affected.
  - i. Date and time Work will be uncovered or altered.
4. Determine the existing conditions, including structures subject to damage or to movement during cutting and patching.
    - a. Inspect conditions affecting installation or products or performance of the Work after uncovering the Work.
    - b. Provide a written report of unacceptable or questionable conditions to the Engineer. The Contractor shall not proceed with Work until Engineer has provided further instructions. Beginning Work will constitute acceptance of existing conditions by the Contractor.
  5. Protect the structure and other parts of the Work and provide adequate support to maintain the structural integrity of the affected portions of the Work. Provide devices and methods to protect adjacent Work and other portions of the Project that may be exposed by cutting and patching Work.
  6. Execute cutting and demolition by methods which will prevent damage to other Work and will provide proper surfaces to receive installation of repairs.
  7. Execute fitting and adjustments of products to provide a finished installation to comply with specified products, functions, tolerances, and finishes.
  8. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to, the removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the modified Work.
  9. Restore permanent facilities used during construction to their specified condition.
  10. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
  11. Fit Work air-tight to pipes, sleeves, ducts, conduit, and other penetrations through the surfaces. Where fire rated separations are penetrated, fill the space around the pipe of insert with materials with physical characteristics equivalent to fire resistance requirements of penetrated surface.
  12. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
  13. Patch finished surfaces and building components using new products specified for the original installation.
  14. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
    - a. For continuous surfaces, refinish to the nearest intersection.
    - b. For an assembly, refinish the entire unit.
- K. Hazardous Environment/Confined Space Entry Plans
1. Contractor shall develop and implement Hazardous Environment/Confined Space Entry Plans for this Project. Plans shall be submitted to the Engineer for record purposes prior to the pre-construction conference. Plans shall include all local, state and federal requirements for entrance to and working in hazardous environments and confined spaces and shall include a written safety plan for the Project.

2. Contractor shall have a safety officer present at the jobsite whenever the Contractor's activities require entering or working in a hazardous environment or confined space.
- L. Plan of Action
1. Contractor shall prepare a detailed, written plan of action (covering all shutdowns, material deliveries, confined space/hazardous environment entries, plant protection system, construction sequence for major facilities and modifications to existing facilities, trench/excavation protection, for review and coordination with the Owner and Engineer at the pre-construction conference. The pre-construction conference will be held prior to beginning construction activities.
- M. Basin Dewatering and Cleaning
1. The Contractor shall clean basins, pipelines and equipment as specified and, when necessary to complete the work. No additional payment will be made for such work. Washdown water shall be contained and disposed of properly.
- N. Workmanship
1. Specifications contain detailed instructions and descriptions of the major items of construction and workmanship necessary for building and completing the various elements of the Project. The Specifications are intended to be written so that only first class workmanship and finish of the best grade and quality will result. The fact that these Specifications may fail to be so complete as to cover all details will not relieve the Contractor of full responsibility for providing a completed project of high quality, first class finish and appearance and satisfactory for operation, all within the apparent intent of the Plans and Specifications.
- O. Firearms
1. Neither the Contractor nor any of his employees shall be allowed to carry firearms on the Project, either on their persons or within their automobiles. Any violation of this requirement will result in the permanent removal from the Project of the employee committing the violation.
- P. Handling Materials Not Approved
1. The Contractor shall remove from the site any materials found to be damaged, and any materials not meeting the specifications. These materials shall be removed promptly, unless the Engineer will accept the materials after repairing. Materials found to be damaged, or not acceptable to the Engineer, shall be removed. Examination before installation shall not relieve the Contractor from any responsibility to furnish good quality materials.
- Q. Surplus and Salvaged Material
1. Surplus equipment or material, which is removed by the Contractor as specified in the Drawings and Specifications, shall become the property of the Contractor. The Contractor shall be responsible for the disposal of salvage material offsite.
  2. Equipment and material designated to be salvage shall be transported by the Contractor to a location as directed by the Resident Project Representative.
- R. Archeological Discoveries
1. No activity, which may affect a State Archeological Landmark, is authorized until the Owner has complied with provisions of the Antiquities Code of Oklahoma. The Owner has previously coordinated with the appropriate agencies and impacts to known

cultural or archeological deposits have been avoided or mitigated. However, the Contractor may encounter unanticipated cultural or archeological deposits during construction.

S. Endangered species

1. No activity is authorized that is likely to jeopardize the continued existence, or a threatened, or endangered species as listed, or proposed for listing, under the Federal Endangered Species Act (ESA), and/or the State of Oklahoma Parks and Wildlife Code on Endangered Species, or to destroy or adversely modify the habitat of such species.
2. If a threatened or endangered species is encountered during construction, the Contractor shall immediately cease work in the area of the encounter and notify the Resident Project Representative, who will immediately implement actions in accordance with the ESA and applicable State statutes. These actions shall include reporting the encounter to the U.S. Fish and Wildlife Service and the Oklahoma Parks and Wildlife Department, obtaining any necessary approvals or permits to enable the continuation of work, or implement other mitigate actions.
3. The Contractor shall not resume construction in the area of the encounter until authorized to do so by the Resident Project Representative.

T. Blasting and Burning

1. Explosives: Do not use explosives.
2. Burying: Waste Disposal: Burying waste materials on-site will not be permitted.
3. Burning: Waste Disposal: No Burning will be allowed.

U. Pipe Closure and Buoyancy of Structures

1. At the end of each working day, the Contractor shall plug the ends of all exposed pipeline to prevent any material or objects from entering the pipeline.
2. The Contractor shall anchor all pipelines and structures to prevent their flotation should rain occur prior to the completion of backfilling to proposed final grade.

V. Final cleaning

1. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
2. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each Project site, equipment, structures, buildings and related facilities. Comply with manufacturer's written instructions.
  - a. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
    - 1) Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - 2) Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - 3) Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - 4) Remove tools, construction equipment, machinery, and surplus material



from Project site.

- 5) Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  - 6) Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  - 7) Sweep concrete floors broom clean in unoccupied spaces.
  - 8) Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
  - 9) Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
  - 10) Remove labels that are not permanent.
  - 11) Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
    - a) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
  - 12) Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - 13) Replace parts subject to unusual operating conditions.
  - 14) Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - 15) Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - 16) Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
  - 17) Leave Project clean and ready for occupancy.
3. Pest Control: Not Used
  4. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

**END OF SECTION**

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**SECTION 01 32 23  
SURVEY AND LAYOUT DATA**

PART 1 - GENERAL

1.1 CONSTRUCTION STAKING

- A. Unless otherwise specified, all construction stakes shall be provided by the Contractor using the benchmarks as shown on the Plans.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GRADES, LINES AND LEVELS

- A. The Contractor shall construct all work under this Contract to the alignments and to within +0.70/-0.00 feet of the grades shown on the Plans. The Contractor shall be responsible for layout, staking and control of all grades, lines, and levels. Permanent benchmarks at the site are provided as shown on the Plans by identified parcel numbers. Contractor shall be responsible for returning the existing grade to the appropriate elevation. The Contractor shall be responsible to verify all elevations have been brought back to existing grade prior to construction.

**END OF SECTION**

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**SECTION 01 32 33**  
**PROJECT DOCUMENTATION**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This section includes the following:
1. Construction Progress Documentation including the following:
    - a. Submittals Schedule.
    - b. Preliminary Network Diagram for Internet-Based Construction Management
    - c. Contractor's Construction Schedule.
    - d. Critical Path Method Reports.
    - e. Daily construction reports.
    - f. Field condition reports.
  2. Photographic documentation.
  3. Submitting Shop Drawings, Product Data, Samples, and other submittals.
  4. Selection of products for use in Project; product delivery, storage, and handling; product substitutions; and comparable products.
  5. Project Record Documents, including the following:
    - a. As-Built Record Drawings.
    - b. As-Built Record Specifications.
  6. Preparing operation and maintenance manuals, including the following:
    - a. Operation and maintenance documentation directory.
    - b. Emergency manuals.
    - c. Operation manuals for systems, subsystems, and equipment.
    - d. Maintenance manuals for the care and maintenance of systems and equipment.
- B. Related Sections include the following:
1. SECTION 01 31 00 PROJECT ADMINISTRATION for submitting the Schedule of Values and Project Closeout Procedures.
  2. SECTION 01 32 39 CONTRACTOR REQUIREMENTS for submitting and distributing meeting and conference minutes.
  3. SECTION 01 78 36 WARRANTIES for submitting warranties.
  4. Divisions 2 through 50 Sections for specific requirements for Project Documentation of the Work in those Sections.

**1.3 CONSTRUCTION PROGRESS DOCUMENTATION**

- A. Submittals
1. Submittals Schedule: Submit schedule per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT. Arrange the following information in a tabular

format:

- a. Scheduled date for first submittal.
  - b. Specification Section number and title.
  - c. Submittal category (action or informational).
  - d. Name of subcontractor.
  - e. Description of the Work covered.
  - f. Scheduled date for Engineer's final release or approval.
2. Contractor's Construction Schedule: Submit initial schedule, large enough to show entire schedule for entire construction period, per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT.
    - a. Submit an electronic copy of schedule. Include type of schedule (Initial or Updated) and date on filename.
  3. Critical Path Method (CPM) Reports: Concurrent with CPM schedule, submit each of the following computer-generated reports per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
    - a. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
    - b. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
    - c. Total Float Report: List of all activities sorted in ascending order of total float.
  4. Daily Construction Reports: Submit, per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT AT weekly intervals.
  5. Field Condition Reports: Submit, per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT at time of discovery of differing conditions.
- B. Coordination
1. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
  2. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
    - a. Secure time commitments for performing critical elements of the Work from parties involved.
    - b. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

#### 1.4 PHOTOGRAPHIC DOCUMENTATION

##### A. Submittals

1. Submit a key plan of Project site with notation of vantage points marked for location and direction of each photograph. Indicate elevation or stage of construction of structure or area. Include same label information as corresponding set of

photographs.

2. Submit digital copies of all image files of each photographic view on CD-ROMs or USB thumb drives within seven 14 days of taking photographs.
  - a. Format: JPEG or TIFF file format.
  - b. Identification: For each image, provide the following information in in a text or Microsoft Word file:
    - 1) Name of Project.
    - 2) Name of Contractor.
    - 3) Date photograph was taken if not date stamped by camera.
    - 4) Description of vantage point, indicating location, direction (by compass point), and elevation or stage of construction.
    - 5) Unique sequential identifier.
  - c. Submit a complete set of digital image electronic files with each submittal of prints as a Project Record Document on CD-ROM or USB thumb drive. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.
- B. Photographer may be member of the Contractor's staff, experienced in construction photography.
- C. Photographer shall be granted access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.
- D. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

#### 1.5 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

- A. Definitions
  1. Action Submittals: Written and graphic information that requires Engineer's responsive action.
  2. Informational Submittals: Written information that does not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.
- B. Submittal Procedures
  1. Coordinate preparation and processing of submittals with performance of construction activities.
    - a. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that requires sequential activity.
    - b. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      - 1) Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
  2. Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

- a. Allow 21 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  - b. If intermediate submittal is necessary, process it in same manner as initial submittal.
  - c. Allow 21 days for review of each resubmittal.
3. Place a permanent label or title block on each submittal for identification.
- a. Indicate name of firm or entity that prepared each submittal on label or title block.
  - b. Provide a space approximately on label or beside title block to record Contractor's review markings (green in color).
  - c. Include the following information on label for processing and recording action taken:
    - 1) Project name.
    - 2) Date.
    - 3) Name and address of Engineer.
    - 4) Name and address of Contractor.
    - 5) Name and address of subcontractor.
    - 6) Name and address of supplier.
    - 7) Name of manufacturer.
    - 8) Submittal number shall be by means of a specification number, a chronological order, and a letter suffices to indicate number of times submitted.
      - a) Submittal number shall use Specification Section number followed by a hyponym and then a sequential number (e.g., 06100-01). Resubmittals shall include an alphabetic suffix after another hyponym (e.g., 06100-01-A).
      - b) Operational and Maintenance Manuals submitted shall be identified with the same number as it's corresponding equipment submittal (e.g., 11300-DRAFT).
    - 9) Number and title of appropriate Specification Section.
    - 10) Drawing number and detail references, as appropriate.
    - 11) Location(s) where product is to be installed, as appropriate.
    - 12) Other necessary identification.
4. Deviations from Contract Documents: Contractor shall highlight, encircle, or otherwise specifically identify deviations (green in color) from the Contract Documents on submittals. Requests for deviation shall be by Contractor's Modification Request in accordance with the requirements of SECTION 01 31 00 PROJECT ADMINISTRATION.
5. Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
6. Package each submittal individually and appropriately for transmittal and handling. Transmit submittals per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION



MANAGEMENT. Engineer will return submittals, without review, received from sources other than Contractor.

7. Make resubmittals in same form and number of copies as initial submittal.
  - a. Note date and content of previous submittal.
  - b. Note date and content of revision in label or title block and clearly indicate extent of revision.
  - c. Resubmit submittals until they are marked "REVIEWED."
  - d. For resubmittals, Contractor shall provide the entire and complete submittal for project documentation. If the Contractor provides only the portions required by the previous shop drawing review, then the Engineer may elect to return the submittal without review.
8. Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, and authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
9. Use only final submittals with mark indicating "REVIEWED" or "Furnished As Corrected" for Construction.

## 1.6 PRODUCT REQUIREMENTS

### A. Definitions

1. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - a. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
  - b. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
  - c. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
2. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
3. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

### B. Submittals

1. Material and Equipment List. Within 60 days after Notice to Proceed, submit a complete list of major products proposed for the Project, with the name of the manufacturer and the installing entity.
2. Substitution Requests: Submit each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - a. Substitution Request Form: Use facsimile of form provided at end of Section.
  - b. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - 1) Statement indicating why specified material or product cannot be provided.
    - 2) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will be necessary to accommodate proposed substitution.
    - 3) Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    - 4) Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - 5) Samples, where applicable or requested.
    - 6) List of similar installations for completed projects with project names and addresses and names and addresses of architects, engineers, and owners.
    - 7) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    - 8) Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
    - 9) Cost information, including a proposal of change, if any, in the Contract Sum.
    - 10) Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
    - 11) Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
  - c. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
    - 1) Form of Acceptance: Change Order or Field Order.
    - 2) Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.

3. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
    - a. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
      - 1) Form of Approval: As specified in in this specification Section.
      - 2) Use product specified if Engineer cannot make a decision on use of a comparable product request within time allocated.
  4. Basis-of-Design Product Specification Submittal: Comply with requirements in this specification Section. Show compliance with requirements.
- C. Quality Assurance
1. If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
  2. Where Contractor design is specified; design of installation, systems, equipment, and components, including supports and anchorage, shall be in with provisions of International Building Code by International Code Council. Refer to the drawings for required design load criteria.
  3. Provide products suitable for installation and operation under rated conditions at 3,256 feet above sea level. Products installed outdoors or in unheated enclosures shall be capable of continuous operation within an ambient temperature range of 0 degrees F to 120 degrees F.
- D. Product Delivery, Storage, And Handling
1. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
  2. Delivery and Handling:
    - a. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
    - b. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
    - c. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
    - d. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
  3. Storage:
    - a. Store products to allow for inspection and measurement of quantity or counting of units.
    - b. Store materials in a manner that will not endanger Project structure.

- c. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  - d. Store cementitious products and materials on elevated platforms.
  - e. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  - f. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  - g. Protect stored products from damage and liquids from freezing.
  - h. Off-site storage of materials and equipment shall be the sole responsibility of the Contractor.
4. Extra Materials, Special Tools, Test Equipment, and Expendables:
- a. Divisions 2 through 50 Sections for specific requirements.
  - b. Schedule:
    - 1) Ensure shipment and delivery occurs concurrent with shipment of product.
    - 2) Transfer to Owner upon acceptance by Contractor of shipment.
  - c. Packaging and Shipment:
    - 1) Package and ship items to avoid damage during long term storage in original cartons or in appropriately sized, hinged-cover, wood, plastic or metal boxes.
    - 2) Prominently display on each package: Part number, consistent with Operation and Maintenance Manual identification system; equipment description, quantity of parts; and equipment manufacturer.
  - d. Deliver to designated location as directed by Engineer.

#### 1.7 PROJECT RECORD DOCUMENTATION

- A. Submit one set of marked-up As-Built Record Drawings.
- B. Submit one copy of marked-up Project Specifications, including addenda and contract modifications.
- C. Submit one copy of each marked-up Product Data submittal.

#### 1.8 OPERATION AND MAINTENANCE MANUALS

- A. Definitions
  - 1. Preliminary Data: Initial and subsequent submissions for Engineer's review.
  - 2. Final Data: Engineer accepted data, submitted as specified herein.
  - 3. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
  - 4. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
  - 5. Subsystem: A portion of a system with characteristics similar to a system.

6. Instructional Manual: Equipment and Operating Data submitted prior to the testing and startup of the equipment, subsystem, or system.
  7. Operation and Maintenance Data: The operation and maintenance data submitted to be included in the Operation and Maintenance Manual for the Project.
- B. Sequencing and Scheduling
1. Equipment and System Data (Instructional manual):
    - a. Preliminary Data:
      - 1) Do not submit until Engineer has approved Shop Drawings.
      - 2) Submit prior to shipment date.
    - b. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing. Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.
- C. Submittals
1. Initial Submittal: Submit draft copy of each Operation and Maintenance Data (Manual) at least 60 days before check-out, start-up or testing of equipment in accordance with SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT. Include a complete operation and maintenance directory. Engineer will review and mark whether general scope and content of Manual is acceptable.
  2. Final Submittal: Submit one (1) copy of each Manual in final form at least 30 days before requesting inspection for Substantial Completion. Engineer will return copy with comments within 15 days of receipt or notify Contractor it is accepted.
    - a. Correct or modify each manual to comply with Engineer's comments. Submit (4) copies of each corrected manual within 15 days of receipt of Engineer's comments. Provide three (3) electronic copies of the final manual in PDF format.
- D. Coordination
1. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

## PART 2 - PRODUCTS

### 2.1 CONSTRUCTION PROGRESS DOCUMENTATION

- A. Submittals Schedule
1. Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
    - a. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
    - b. Submit concurrently with the first complete submittal of Contractor's Construction Schedule.
- B. Contractor's Construction Schedule, General
1. Extend schedule from date established for the Notice to Proceed to date of Final

Completion.

- a. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
  2. Treat each facility or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
    - a. Activity Duration: Define activities so no activity is longer than approximately 20 days.
    - b. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
    - c. Submittal Review Time: Include review and resubmittal times.
    - d. Startup and Testing Time: Include time for equipment testing and facility startup.
    - e. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
  3. Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
    - a. Indicate important stages of construction for each major portion of the Work.
  4. Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
  5. For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.
- C. Contractor's Construction Schedule
1. Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
  2. Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
    - a. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.
- D. Contract Time
1. Contract time cannot be changed by the submission of progress changes. Contract time can only be modified by approved Change Order.
- E. Reports
1. Prepare a daily construction report recording the following information concerning events at Project site:
    - a. List of subcontractors at Project site.
    - b. Equipment at Project site.
    - c. Material deliveries.

- d. High and low temperatures and general weather conditions.
  - e. Accidents.
  - f. Stoppages, delays, shortages, and losses.
  - g. Meter readings and similar recordings.
  - h. Orders and requests of authorities having jurisdiction.
  - i. Services connected and disconnected.
  - j. Equipment or system tests and startups.
- F. Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## 2.2 PHOTOGRAPHIC DOCUMENTATION

### A. Photographic Media

1. Digital Images: Provide images in JPEG or TIFF format, produced by a digital camera with minimum sensor size of 20 megapixels, and at an image resolution of up to 5152 by 3864 pixels.

## 2.3 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

### A. Action Submittals

1. Prepare and submit Action Submittals required by individual Specification Sections.
2. Collect information into a single submittal for each element of construction and type of product or equipment.
  - a. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - b. Mark each copy of each submittal to show which products and options are applicable.
  - c. When pre-printed catalog information is submitted, clearly identified item to be submitted with arrow or other mark. Catalog information not marked clearly shall be returned.
  - d. Include the following information, as applicable:
    - 1) Manufacturer's written recommendations.
    - 2) Manufacturer's product specifications.
    - 3) Manufacturer's installation instructions.
    - 4) Manufacturer's catalog cuts.
    - 5) Wiring diagrams showing factory-installed wiring.
    - 6) Printed performance curves.
    - 7) Operational range diagrams.
    - 8) Compliance with specified referenced standards.
    - 9) Testing by recognized testing agency.
  - e. Submit Product Data electronically in accordance with SECTION
  - f. 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT.

3. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal of Engineer's CAD Drawings is otherwise permitted.
  - a. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - 1) Dimensions.
    - 2) Identification of products.
    - 3) Fabrication and installation drawings.
    - 4) Roughing-in and setting diagrams.
    - 5) Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    - 6) Shop work manufacturing instructions.
    - 7) Templates and patterns.
    - 8) Schedules.
    - 9) Notation of coordination requirements.
    - 10) Notation of dimensions established by field measurement.
    - 11) Relationship to adjoining construction clearly indicated.
    - 12) Seal and signature of professional engineer if specified.
    - 13) Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
    - 14) Electrical requirements.
    - 15) Limits of or range of operation.
    - 16) Performance curves.
  - b. Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
  - c. Submit Shop Drawings electronically in accordance with SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT.
4. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
  - a. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  - b. Identification: Attach label on unexposed side of Samples that includes the following:
    - 1) Generic description of Sample.
    - 2) Product name and name of manufacturer.
    - 3) Sample source.
    - 4) Number and title of appropriate Specification Section.
  - c. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.



- d. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
  - 1) Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
- e. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - 1) Submit two sets of Samples. Engineer will retain one Sample set; remainder will be returned.
- 5. As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location.
  - a. Submit three copies of product schedule or list, unless otherwise indicated. Engineer will return two copies.
- 6. Schedule of Values: Comply with requirements specified in SECTION 01 31 00 PROJECT ADMINISTRATION.
- 7. Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.

**B. INFORMATIONAL SUBMITTALS**

- 1. Prepare and submit Informational Submittals required by other Specification Sections.
  - a. Submit per SECTION INTERNET-BASED CONSTRUCTION MANAGEMENT unless otherwise indicated.
  - b. Provide a notarized statement that includes signature of entity responsible for preparing certification. An officer shall sign certificates and certifications or other individual authorized to sign documents on behalf of that entity.
  - c. Test and Inspection Reports: Comply with requirements specified in each Specification Section.
- 2. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- 3. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- 4. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

5. **Manufacturer Certificates:** Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
6. **Product Certificates:** Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
7. **Material Certificates:** Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
8. **Material Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
9. **Product Test Reports:** Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
10. **Compatibility Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
11. **Field Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
12. **Operational and Maintenance Data:** Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. **Design Data:** Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
13. **Manufacturer's Instructions:** Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.
14. **Manufacturer's Field Reports:** Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
  - a. Statement on condition of substrates and their acceptability for installation of product.
  - b. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  - c. Results of operational and other tests and a statement of whether observed performance complies with requirements.
15. **Insurance Certificates and Bonds:** Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
16. **Material Safety Data Sheets (MSDS):** Submit information directly to Owner; do not

submit to Engineer.

- a. Engineer will not review submittals that include MSDS and will return them for resubmittal.

#### C. DELEGATED DESIGN

1. Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
2. In addition to Shop Drawings, Product Data, and other required submittals, submit per SECTION 01 10 39 INTERNET-BASED CONSTRUCTION MANAGEMENT signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

### 2.4 PRODUCT REQUIREMENTS

#### A. PRODUCT SELECTION PROCEDURES

1. Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
  - a. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - b. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - c. Like items of products furnished and installed shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions.
  - d. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.
  - e. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  - f. Where products are accompanied by the term "as selected," Engineer will make selection.
  - g. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
  - h. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
  - i. Regulatory Requirements: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
  - j. Safety Guards:

- 1) Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal.
  - 2) Use 16-gauge or heavier; galvanized steel, aluminum, coated steel and ½-inch mesh expanded steel.
  - 3) For outdoor installations prevent entrance of rain or dripping water.
  - k. Provide Work in accordance with NFPA 70, National Electrical code, and be labeled by a nationally recognized testing laboratory or other agency acceptable to the authority having jurisdiction.
  - l. Equipment Finish:
    - 1) Provide manufacturer's standard finish and color, except where specific color is indicated.
    - 2) If manufacturer does not have a standard color, provide color as approved by Engineer.
  - m. Provide to Owner all special tools and accessories required placing equipment in operation. These include, but not limited to, adequate oil and grease (as required for first servicing of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts required for maintenance.
  - n. Provide initial lubricant recommended by manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, start-up, and operation until final acceptance by Owner.
2. Fabrication and Manufacture:
- a. General Requirements:
    - 1) Manufacture parts to U.S.A. standard sizes and gauges.
    - 2) Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
    - 3) Design structural members for anticipated shock and vibratory loads.
    - 4) Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
    - 5) Modify standard products as necessary to meet performance specifications.
  - b. Lubrication System Requirements:
    - 1) Require no more than weekly attention during continuous operation.
    - 2) Convenient and accessible. Oil drains, with bronze or stainless steel valves, and fill-plugs easily accessible from normal operating area or platform. Locate drains to allow convenient collection of oil during changes without removing equipment from its installed position.
    - 3) Provide constant-level oilers or oil level indicators for oil lubrication systems.
    - 4) For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.
3. Product Selection Procedures:

- a. Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
- b. Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
- c. Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that comply with requirements.
- d. Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
- e. Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
- f. Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
- g. Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
- h. Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
- i. Where Specifications require matching an established Sample, select a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
  - 1) If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
- j. Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product that complies with other specified requirements.
  - 1) Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
  - 2) Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.5 PRODUCT SUBSTITUTIONS

- A. Engineer will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
  - 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
  - 2. Requested substitution does not require extensive revisions to the Contract Documents.
  - 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
  - 4. Substitution request is fully documented and properly submitted.
  - 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
  - 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - 7. Requested substitution is compatible with other portions of the Work.
  - 8. Requested substitution has been coordinated with other portions of the Work.
  - 9. Requested substitution provides specified warranty.

## 2.6 COMPARABLE PRODUCTS

- A. Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
  - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, which it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - 3. Evidence that proposed product provides specified warranty.
  - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  - 5. Samples, if requested.

## 2.7 REUSE OF EXISTING MATERIAL

- A. Except as specifically indicated or specified, materials and equipment removed from existing facilities shall not be used in the completed Work.
- B. For materials and equipment designated for reuse in the Work:
  - 1. Use special care in removal, handling, storage, and installation to ensure proper

function in the completed Work.

2. Arrange for transportation, storage and handling of the products when offsite storage, restoration, or renovation. All costs associated with this work are the Contractor's responsibility.

## 2.8 PROJECT RECORD DOCUMENTATION

### A. As-Built Drawings

1. Contractor shall maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  - a. Mark As-Built Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained As-Built data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up As-Built Prints.
    - 1) Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - 2) Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  - b. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - d. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
2. Format: Identify and date each As-Built Drawing; include the designation "Project As-Built Drawing" in a prominent location.
  - a. Include identification on cover sheets.
  - b. Identification: As follows:
    - 1) Date.
    - 2) Designation "Project As-Built Drawings."
    - 3) Name of Engineer.
    - 4) Name of Contractor.

### B. Miscellaneous record submittals

1. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and found or filed, ready for use and reference. Miscellaneous records include, but are not limited to, the following:
  - a. Field records on excavations and foundations.
  - b. Field records on underground construction and similar work.
  - c. Surveys showing locations and elevations of underground lines.
  - d. Invert elevations of drainage pipes.
  - e. Surveys establishing building lines and levels.

- f. Records of equipment testing, start-up, and operation.
- g. Certifications received in lieu of labels on bulk products.
- h. Batch mixing and bulk delivery tickets.
- i. Documented qualifications of installation firms.
- j. Inspections and certification of governing agencies.
- k. Load and performance testing.
- l. Results of pressure testing of lines.
- m. Final inspection and correction procedures.

## 2.9 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance documentation directory
  - 1. Include a section in the directory for each of the following:
    - a. List of documents.
    - b. List of systems.
    - c. List of equipment.
    - d. Table of contents.
  - 2. List systems alphabetically or by treatment area as directed by Engineer. Include references to operation and maintenance manuals that contain information about each system.
  - 3. List equipment for each system, organized alphabetically by system or by treatment area as directed by Engineer. For pieces of equipment not part of system, list alphabetically in separate list.
  - 4. Include a table of contents for each emergency, operation, and maintenance manual.
  - 5. In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents.
- B. Manuals, General
  - 1. Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
    - a. Title page.
    - b. Table of contents.
    - c. Manual contents.
  - 2. Enclose title page in transparent plastic sleeve. Include the following information:
    - a. Subject matter included in manual.
    - b. Name and address of Project.
    - c. Name and address of Owner.
    - d. Name, address, and telephone number of Contractor.
    - e. Name and address of Engineer.
    - f. Subcontractor, Supplier, Manufacturer, Installer, or Maintenance Contractor's name, address, and telephone number, as appropriate.
      - 1) Identify area of responsibility of each.



- 2) Provide name and telephone number of local source of supply for parts, replacement, and service.
- g. Cross-reference to related systems in other operation and maintenance manuals.
3. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
  - a. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
4. Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
  - a. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - 1) If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - 2) Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. \_\_\_ OF \_\_\_", Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
    - 3) Text: Manufacturer's printed data, or neatly typed.
    - 4) Three-hole punch data for binding and composition; arrange printing so punched holes do not obliterate data.
  - b. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Manual.
  - c. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
  - d. Supplementary Text: Prepared on 8-1/2-by-11-inch 20-, white bond paper.
  - e. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - 1) If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - 2) If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
  - f. Electronic Media Format:

- 1) Portable Document format (PDF)
  - a) After all preliminary data has been found to be acceptable, submit operational and maintenance data in PDF format on CD-ROM.
  - b) Files to be exact duplicates of accepted preliminary data. Arrange by specification Section number. Bookmark sections.
  - c) Files to be fully functional and viewable in most recent version of Adobe Acrobat.
- 2) Manufacturer's Standard Electronic Format:

C. Operation Manuals

1. In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  - a. System, subsystem, and equipment descriptions.
  - b. Performance and design criteria.
  - c. Operating standards.
  - d. Operating procedures.
  - e. Operating logs.
  - f. Wiring diagrams.
  - g. Control diagrams.
  - h. Piped system diagrams.
  - i. Precautions against improper use.
  - j. License requirements including inspection and renewal dates.
2. Include the following:
  - a. Product name and model number.
  - b. Manufacturer's name.
  - c. Equipment identification with serial number of each component.
  - d. Equipment function.
  - e. Operating characteristics.
  - f. Limiting conditions.
  - g. Performance curves.
  - h. Engineering data and tests.
  - i. Complete nomenclature and number of replacement parts.
3. Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Instructions on stopping.
  - f. Normal shutdown instructions.
  - g. Seasonal and weekend operating instructions.
  - h. Required sequences for electric or electronic systems.
  - i. Special operating instructions and procedures.

4. Describe the sequence of operation, and diagram controls as installed.
  5. Diagram piping as installed and identifies color-coding where required for identification.
- D. Product Maintenance Manual
1. Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
  2. List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
  3. Include the following, as applicable:
    - a. Product name and model number.
    - b. Manufacturer's name.
    - c. Color, pattern, and texture.
    - d. Material and chemical composition.
    - e. Reordering information for specially manufactured products.
  4. Include manufacturer's written recommendations and the following:
    - a. Inspection procedures.
    - b. Types of cleaning agents to be used and methods of cleaning.
    - c. List of cleaning agents and methods of cleaning detrimental to product.
    - d. Schedule for routine cleaning and maintenance.
    - e. Repair instructions.
  5. Include lists of materials and local sources of materials and related services.
  6. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
    - a. Include procedures to follow and required notifications for warranty claims.
- E. Systems and Equipment Maintenance Manual
1. For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
  2. List each system, subsystem, and piece of equipment included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
  3. Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
    - a. Standard printed maintenance instructions and bulletins.
    - b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.

- c. Identification and nomenclature of parts and components.
  - d. List of items recommended to be stocked as spare parts.
4. Include the following information and items that detail essential maintenance procedures:
    - a. Test and inspection instructions.
    - b. Troubleshooting guide.
    - c. Precautions against improper maintenance.
    - d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    - e. Aligning, adjusting, and checking instructions.
    - f. Demonstration and training videotape, if available.
  5. Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
    - a. Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
    - b. Include manufacturers' forms for recording maintenance.
  6. Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
  7. If applicable, include copies of maintenance agreements with name and telephone number of service agent.
  8. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
    - a. Include procedures to follow and required notifications for warranty claims.

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION PROGRESS DOCUMENTATION

#### A. Contractor's construction schedule

1. At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
  - a. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  - b. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  - c. As the Work progresses, indicate Actual Completion percentage for each activity.
2. Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

- a. Post copies in Project meeting rooms and temporary field offices.
- b. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

### 3.2 PHOTOGRAPHIC DOCUMENTATION

#### A. Construction photographs

1. Engage a qualified photographer to take the preconstruction, initial, monthly progress, final aerials, and final construction photographs. The photographer may be a member of the Contractor's staff, experienced in construction photography.
2. Photographer shall be granted access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.
3. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.
4. Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Images with blurry or out-of-focus areas will not be accepted.
  - a. Maintain key plan with each set of construction photographs that identifies each photographic location.
5. Images:
  - a. Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
  - b. Retain progress photographs in the field office at Project site, available at all times for reference. Identify photographs same as for those submitted to Engineer.
6. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
  - a. Include date and time in filename for each image.
  - b. Maintain one set of images on CD-ROM or USB thumb drive in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Engineer.
7. Before starting construction, take color photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.
  - a. Flag construction limits before taking construction photographs.
  - b. Provide one aerial photograph of Project site prior to start of construction.
  - c. Take a minimum of ten (10) photographs to show existing conditions adjacent to property before starting the Work.
  - d. Take photographs of existing facilities either on or adjoining property to accurately record physical conditions at start of construction.
8. Take a minimum of two (2) color photographs of each structure or area under construction monthly, coinciding with the cutoff date associated with each Application for Payment. As approved by Engineer, select vantage points to show

status of construction and progress since last photographs were taken.

9. Provide a minimum of twenty (20) color photographs and two (2) aerial photographs of Project site following construction.
10. Engineer may issue requests for additional photographs, in addition to periodic photographs specified.
  - a. Three days' notice will be given, where feasible.
  - b. In emergency situations, take additional photographs within 24 hours of request.
  - c. Circumstances that could require additional photographs include, but are not limited to, the following:
    - 1) Special events planned at Project site.
    - 2) Immediate follow-up when on-site events result in construction damage or losses.
    - 3) Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    - 4) Substantial Completion of a major phase or component of the Work.
    - 5) Extra record photographs at time of final acceptance.
    - 6) Owner's request for special publicity photographs.

### 3.3 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

#### A. Contractor's Review

1. Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall insure the values, material, equipment, or method of work shall be as described.
2. Contractor shall insure there is no conflict with other submittals and shall notify Engineer of each case where a conflict may occur.
3. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp (green in color) before submitting to Engineer.
4. Approval Stamp: Stamp each submittal with a uniform, approval stamp (green in color). Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

#### B. Engineer's Action

1. Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Engineer will review each action submittal, make marks to indicate corrections or modifications required, and return it. Engineer will either stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, or use the Shop Drawing Review Comments Form listed in Part 3 to indicate the action taken for each submittal as follows:
  - a. REVIEWED

- 1) Contractor may incorporate product(s) or implement Work covered by submittal.
  - b. FURNISHED AS CORRECTED
    - 1) Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
  - c. REVISE AND RESUBMIT
    - 1) Make corrections or obtain missing portions and resubmit.
  - d. REJECTED
    - 1) Contractor may not incorporate product(s) or implement Work covered by submittal.
3. Engineer will review each information submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
  4. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
  5. Submittals not required by the Contract Documents may not be reviewed and may be discarded.
- C. Supplements
1. Sample forms included after "End of Section" are considered part of this Section and can be provided electronically.
    - a. Shop Drawing Transmittal.
    - b. Shop Drawing Review Comments.
- D.

### 3.4 PRODUCT REQUIREMENTS

- A. Work in accordance with manufacturer's instructions
1. When the specification Section requires the Work to be accomplished in accordance with "manufacturer's instructions", obtain and distribute copies of such instructions to parties involved in the installation. Submit instructions as required per this Section and maintain one set at the Project site.
  2. Handle, install, connect, clean, condition and adjust products in strict accordance with the manufacturer's instructions and in conformity with the Contract Documents. Do not omit any preparatory step or installation procedures. In case of conflict between job conditions or Contract Documents with manufacturer's instructions notify Engineer.
  3. Upon completion of installation, obtain Certificate of Installation from manufacturer's representative.
- B. Inspection
1. Inspect products for signs of pitting, rust decay, or other deleterious effects of storage. Do not install products showing such effects. Remove damaged product from Project site and expedite delivery of identical new product. Delays to Work resulting from product damage, which necessitates procurement of new product, will be considered delays within Contractor's control.
- C. Installation

1. Drawings show general locations for product installation, unless specially dimensioned.
2. No shimming between machined surfaces is allowed.
3. Install Work in accordance with NECA Standard of Installation, unless otherwise specified.
4. Recoat finish surfaces that are damaged prior to final acceptance of Work.
5. Do not cut or notch any structural member or building surface without specific approval of Engineer.
6. Handle, install, connect, clean, condition, and adjust product in accordance with Contract Documents and manufacturer's instructions.
7. Apply field coating in accordance with Contract Documents.
8. Perform required adjustments, tests, operation checks, and other start-up activities.
9. Fill lubricant reservoirs and replace consumption during testing, start-up, and operation prior to final acceptance of Work by Owner.

D. Supplements

1. Sample forms included after "End of Section" are considered part of this Section:
  - a. Substitution Request.

### 3.5 OPERATION AND MAINTENANCE DOCUMENTATION

A. Recording and maintenance

1. Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
2. Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

B. Manual Preparation

1. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
2. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
3. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
4. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
  - a. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.



- b. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
  5. Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
    - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
  6. Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
    - a. Do not use original Project Record Documents as part of operation and maintenance manuals.
    - b. Comply with requirements of newly prepared Record Drawings in this specification Section.
  7. Comply with this specification Section for schedule for submitting operation and maintenance documentation.
  8. Maintenance Summary:
    - a. Compile individual Maintenance Summary Form for each applicable equipment item, respective unit, or system and for components or sub-units.
    - b. Format:
      - 1) Use Maintenance Summary Form included with this Section as a guide.
      - 2) Use only 8-1/2 by 11-inch size paper.
    - c. Include detailed lubrication instructions and diagrams showing points to be greased or oiled, as well as recommended type, grade, and temperature range of lubricants and frequency of lubrication.
    - d. Recommended Spare Parts:
      - 1) Data to be consistent with manufacturer's Bill of Materials/Parts List furnished with the Operation and Maintenance Data.
      - 2) "Unit" is the unit of measure for ordering part.
      - 3) "Quantity" is the number of units recommended.
      - 4) "Unit Cost" is the current purchase price.
- C. Data for Materials and Finishes
1. Content for Architectural Products, Applied Materials, and Finishes:
    - a. Manufacturer's data, giving full information on products:
      - 1) Catalog number, size, and composition.
      - 2) Color and texture designations.
      - 3) Information required for reordering special-manufactured products.
    - b. Instructions for Care and Maintenance:

- 1) Manufacturer's recommendation for types of cleaning agents and methods.
    - 2) Cautions against cleaning agents and methods that are detrimental to product.
    - 3) Recommended schedule for cleaning and maintenance.
  2. Content for Moisture Protection and Weather Exposed Products:
    - a. Manufacturer's data, giving full information on products:
      - 1) Applicable standards.
      - 2) Chemical composition.
      - 3) Details of installation.
    - b. Instructions for inspection, maintenance, and repair.
- D. Supplements
  1. Sample forms included after "End of Section" are considered part of this Section.
    - a. Maintenance Summary Form.

**END OF SECTION**



# SUBSTITUTION REQUEST (After the Bidding Phase)

Project: \_\_\_\_\_ Substitution Request Number: \_\_\_\_\_  
 \_\_\_\_\_  
 From: \_\_\_\_\_  
 To: \_\_\_\_\_ Date: \_\_\_\_\_  
 \_\_\_\_\_  
 A/E Project Number: \_\_\_\_\_  
 Re: \_\_\_\_\_ Contract For: \_\_\_\_\_

Specification Title: \_\_\_\_\_ Description: \_\_\_\_\_  
 Section: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
 Trade Name: \_\_\_\_\_ Model No.: \_\_\_\_\_  
 Installer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
 History:  New product  2-5 years old  5-10 yrs old  More than 10 years old

Differences between proposed substitution and specified product: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Point-by-point comparative data attached - REQUIRED BY A/E

Reason for not providing specified item: \_\_\_\_\_  
 \_\_\_\_\_

Similar Installation:  
 Project: \_\_\_\_\_ Architect: \_\_\_\_\_  
 Address: \_\_\_\_\_ Owner: \_\_\_\_\_  
 \_\_\_\_\_ Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work:  No  Yes; explain \_\_\_\_\_  
 \_\_\_\_\_

Savings to Owner for accepting substitution: (\$ \_\_\_\_\_).

Proposed substitution changes Contract Time:  No  Yes [Add] [Deduct] \_\_\_\_\_ days.

Supporting Data Attached:  Drawings  Product Data  Samples  Tests  Reports  \_\_\_\_\_

**SUBSTITUTION  
REQUEST**  
(Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: \_\_\_\_\_  
Signed by: \_\_\_\_\_  
Firm: \_\_\_\_\_  
Address: \_\_\_\_\_  
\_\_\_\_\_  
Telephone: \_\_\_\_\_  
Attachments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

A/E's REVIEW AND ACTION

- Substitution approved - Make submittals in accordance with SECTION 01 32 33 PROJECT DOCUMENTATION
- Substitution approved as noted - Make submittals in accordance with SECTION 01 32 33 PROJECT DOCUMENTATION
- Substitution rejected - Use specified materials.
- Substitution Request received too late - Use specified materials.

Signed by: \_\_\_\_\_ Date: \_\_\_\_\_

Additional Comments:       Contractor       Subcontractor       Supplier       Manufacturer       A/E       \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**MAINTENANCE SUMMARY FORM**

PROJECT: \_\_\_\_\_ CONTRACT NO: \_\_\_\_\_

EQUIPMENT ITEM: \_\_\_\_\_

MANUFACTURER: \_\_\_\_\_

EQUIPMENT TAG NOS.: \_\_\_\_\_

WEIGHT OF INDIVIDUAL COMPONENTS (Over 100 Pounds): \_\_\_\_\_

NAME PLATE DATA (HP, Voltage, Speed, etc.): \_\_\_\_\_

Manufacturer's Local Representative: \_\_\_\_\_

Name: \_\_\_\_\_ Telephone No. \_\_\_\_\_

Address: \_\_\_\_\_

Maintenance Operation Requirements	Frequency	Lubricant
List briefly each maintenance operation required and refer to specific information in manufacturer's maintenance manual, if applicable. Also note tools needed for each maintenance operation and safety considerations.	List frequency of each maintenance operation.	Refer by symbol to lubricant required.

**MAINTENANCE SUMMARY FORM (Continued)**

**LUBRICANT LIST**

Reference Symbol	Mfgr _____	Mfgr _____	Mfgr _____
List symbols used in maintenance requirements	List equivalent lubricants of several manufacturers'		

**RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY**

Part No.	Description	Unit	Quantity	Unit Price

**SECTION 01 32 39**  
**CONTRACTOR REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes:
  - 1. Management and Coordination
  - 2. Coordination
  - 3. Project Meetings
  - 4. Request for Information
  - 5. Quality Assurance and Quality Control
    - a. Owner Quality Control
    - b. Contractor Quality Control
  - 6. Project Identification Sign
  - 7. Temporary Utilities and Facilities
  - 8. Environmental Controls
  - 9. Security and Protection Facilities
  - 10. Traffic Control
  - 11. Archeological Discoveries
  - 12. Endangered Species
- B. Related Sections include the following:
  - 1. SECTION 01 31 00 PROJECT ADMINISTRATION for changes to the Contract Documents.
  - 2. SECTION 01 32 33 PROJECT DOCUMENTATION for preparing and submitting Contractor's Construction Schedule, Testing and Inspection Schedule, and Project Closeout Documents.
  - 3. Divisions 2 through 50 Sections for specific test and inspection requirements.

**1.3 MANAGEMENT AND COORDINATION**

- A. Definitions
  - 1. RFI: Request for Information from Contractor seeking interpretation or clarification of the Contract Documents.
- B. Coordination
  - 1. Coordinate construction operations to ensure efficient and orderly installation of each part of the Work.
    - a. Schedule construction operations in sequence required obtaining the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
    - b. Coordinate installation of different components with other contractors to

- ensure maximum accessibility for required maintenance, service, and repair.
      - c. Make adequate provisions to accommodate items scheduled for later installation.
      - d. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
  - 2. Coordinate scheduling of construction activities to avoid conflicts and to ensure orderly progress of the Work. Activities include, but are not limited to, the following:
    - a. Preparation of Contractor's Construction Schedule.
    - b. Preparation of the Schedule of Values.
    - c. Installation and removal of temporary facilities and controls.
    - d. Delivery and processing of submittals.
    - e. Progress meetings.
    - f. Pre-installation conferences.
    - g. Project closeout activities.
    - h. Startup and adjustment of systems.
- C. Project Meetings
  - 1. Engineer shall schedule a preconstruction meeting before starting construction, at a time convenient to Owner, Engineer, and Contractor. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
    - a. Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants shall be familiar with Project and authorized to conclude matters relating to the Work.
    - b. Discuss items of significance including the following:
      - 1) Construction Schedule.
      - 2) Construction Phasing.
      - 3) Critical work sequencing and long-lead items.
      - 4) Designation of key personnel and their duties.
      - 5) Procedures for processing field decisions and Change Orders.
      - 6) Procedures for RFIs.
      - 7) Procedures for testing and inspecting.
      - 8) Procedures for processing Applications for Payment.
      - 9) Distribution of the Contract Documents.
      - 10) Submittal procedures.
      - 11) Environmental requirements.
      - 12) Preparation of Record Documents.
      - 13) Owner Facilities and Utilities
      - 14) Use of the premises.
      - 15) Work restrictions.



- 16) Responsibility for temporary facilities and controls.
  - 17) Construction waste management and recycling.
  - 18) Parking availability.
  - 19) Office, work, and storage areas.
  - 20) Equipment deliveries and priorities.
  - 21) First aid.
  - 22) Security.
  - 23) Progress cleaning.
  - 24) Work hours.
- c. Contractor Quality Control Plan (CQCP), quality assurance and control system will be discussed prior to the submittal of the CQCP. A mutual understanding of the system details, including the forms for recording CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of the Contractor's management and control with the Owner's Quality Assurance.
  - d. Engineer will record and distribute meeting minutes.
2. Engineer shall schedule and conduct progress meetings at monthly intervals. Coordinate dates of meetings with preparation of payment requests.
    - a. In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
    - b. Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
      - 1) Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 2) Review schedule for next period.
    - c. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.
      - 2) Sequence of operations.
      - 3) Status of submittals.
      - 4) Deliveries.
      - 5) Off-site fabrication.
      - 6) Access.
      - 7) Site utilization.
      - 8) Temporary facilities and controls.
      - 9) Work hours.

- 10) Hazards and risks.
  - 11) Progress cleaning.
  - 12) Quality and work standards.
  - 13) Status of correction of deficient items.
  - 14) Field observations.
  - 15) RFIs.
  - 16) Status of proposal requests.
  - 17) Pending changes.
  - 18) Status of Change Orders.
  - 19) Pending claims and disputes.
  - 20) Documentation of information for payment requests.
- d. Engineer will record and distribute to Contractor the meeting minutes.
  - e. Contractor shall distribute minutes of the meeting to each subcontractor present and to parties who should have been present.
  - f. Contractor shall revise Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
3. Contractor will conduct pre-installation meetings at Project site before each activity that requires coordination with other construction or Owner operation.
    - a. Contractor and manufacturer's representative involved in or affected by the installation and its coordination or integration into the Work shall attend the meeting. Notify Engineer and Owner of scheduled meeting dates.
    - b. Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following items as applicable:
      - 1) The Contract Documents.
      - 2) Related RFIs.
      - 3) Related Change Orders.
      - 4) Purchases.
      - 5) Deliveries.
      - 6) Submittals.
      - 7) Review of mockups.
      - 8) Possible conflicts.
      - 9) Compatibility problems.
      - 10) Time schedules.
      - 11) Weather limitations.
      - 12) Manufacturer's written recommendations.
      - 13) Warranty requirements.
      - 14) Temporary facilities and controls.
      - 15) Space and access limitations.
      - 16) Regulations of authorities having jurisdiction.
      - 17) Testing and inspecting requirements.

- 18) Installation procedures.
  - 19) Coordination with other work.
  - 20) Required performance results.
  - 21) Protection of adjacent work.
  - 22) Protection of construction and personnel.
- c. Record significant discussions, agreements, and disagreements, including required corrective measures and actions Contractor shall distribute meeting minutes to each party present, the Owner and Engineer.
  - d. Contractor will conduct Unit Process Testing and Startup Meeting(s) and Facility Startup Meeting(s) to discuss testing and startup schedules, test methods, required materials and utilities for Contractor installed Products, Unit Processes, and Facilities. Discussions will include Operation Interface, Owner and Engineer involvement.
  - e. Contractor's testing and startup schedule shall be approved by the Owner and Engineer prior to commencing with any testing procedures.
  - f. Schedule a minimum of one facility testing and startup meeting. This meeting will be held prior to submitting Facility Startup and Performance Demonstration Plan.
  - g. Agenda items will include as a minimum; the objectives of the testing and startup, what actions and work will be included, the coordination between the various parties, and potential problems associated with startup.
  - h. Attendees will include Contractor and Contractor QC Manager, subcontractors and manufacturer's representatives, Engineer and Owner representatives.
  - i. Individual Product and Unit Process Meetings will be required to discuss Product and Process startups not discussed at other meetings or as requested by the Owner and Engineer.
  - j. Manufacturer's representative involved in the installation and its coordination or integration into the Work shall attend the meeting.
  - k. All Testing and Startup Meetings shall include discussion of the following items as applicable:
    - 1) Operation and Maintenance Manuals.
    - 2) Possible conflicts.
    - 3) Compatibility problems.
    - 4) Time schedules.
    - 5) Weather limitations.
    - 6) Manufacturer's written recommendations.
    - 7) Warranty Start Dates.
    - 8) Temporary facilities, utilities and controls.
    - 9) Space and access limitations.
    - 10) Inspection and Checkout prior to testing.
    - 11) Installation procedures.
    - 12) Lubrication and Alignment requirements.
    - 13) Coordination with other work.

- 14) Required performance and test results.
  - 15) Protection of adjacent work.
  - 16) Protection of construction and operation personnel.
- I. Record significant meeting discussions, agreements, and disagreements, including required corrective measures and actions. Contractor shall distribute meeting minutes to each party present, the Owner and Engineer.
- D. Requests For Information (RFI)
1. Immediately on discovery of the need for interpretation or information of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI per SECTION 01 10 39 INTERNET BASED CONSTRUCTION MANAGEMENT.
    - a. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
    - b. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
    - c. Include a detailed, legible description of item needing interpretation and the following:
      - 1) Project name.
      - 2) Date.
      - 3) Name of Contractor.
      - 4) Name of Engineer.
      - 5) RFI number, numbered sequentially.
      - 6) Specification Section number and title and related paragraphs, as appropriate.
      - 7) Drawing number and detail references, as appropriate.
      - 8) Field dimensions and conditions, as appropriate.
      - 9) Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
      - 10) Contractor's signature.
      - 11) Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
    - d. Engineer will review each RFI, determine action required, and return it. Allow seven working days for Engineer's response for each RFI. RFIs received after 1:00 p.m. local time will be considered as received the following working day.
      - 1) The following RFIs will be returned without action:
        - Requests for approval of submittals.
        - Requests for approval of substitutions.
        - Requests for coordination information already indicated in the Contract Documents.
        - Requests for adjustments in the Contract Time or the Contract Sum.
        - Requests for interpretation of Engineer's actions on submittals.
        - Incomplete RFIs or RFIs with numerous errors.
      - 2) Engineer's action may include a request for additional information, in which

case Engineer's time for response will start again.

- 3) Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.
  - 4) On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.
  - 5) RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly.
  - 6) Project name.
  - 7) Name and address of Contractor.
  - 8) Name and address of Engineer.
  - 9) RFI number including RFIs that were dropped and not submitted.
  - 10) RFI description.
  - 11) Date the RFI was submitted.
  - 12) Date Engineer's response was received.
  - 13) Identification of related Field Order and Proposal Request, as appropriate.
- e. Utilize Internet-Based Construction Management program for Request for Information Form.

#### 1.4 QUALITY ASSURANCE AND QUALITY CONTROL

##### A. Owner Quality Control

1. Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
2. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
3. Costs for retesting and re-inspecting materials of construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor,
4. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - a. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - 1) Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - b. Contractor shall pay for all charges of testing laboratory services in connection with tests made in the field or laboratory for the following, but not limited to, services:
    - 1) Concrete mix designs, design of asphalt mixtures, lime stabilization of

- subgrade, flowable mix design, and related design parameter determinations.
- 2) Soil test for classifications of on-site and off-site borrow materials, soil densities and moisture determination of subgrade and embankment materials, cement or lime stabilization of subgrade, and other related testing required during construction.
  - 3) Weld inspection, coating inspections, torque requirements for steel erection, and other non-destructive testing.
  - 4) Vacuum and pressure testing of pipe lines, manholes, and related work, including disinfection testing of potable water lines and CCTV of lines.
  - 5) All other inspection and testing work not specifically stated to be the Owner's responsibility.
- c. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  - d. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, distribution as indicated, of each quality-control service.
    - 1) Engineer: two (2) copies
    - 2) Contractor: two (2) copies
    - 3) Owner: three (3) copies
  - e. Testing and inspecting desired by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - f. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
5. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections. The Testing Agency shall:
- a. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  - b. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  - c. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  - d. Submit a certified written report, distribution as indicated, of each test, inspection, and similar quality-control service.
    - 1) Engineer: two (2) copies
    - 2) Contractor: two (2) copies
    - 3) Owner: three (3) copies
  - e. Not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  - f. Not perform any duties of Contractor.
6. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment

of personnel. Provide the following:

- a. Access to the Work.
  - b. Incidental labor and facilities necessary to facilitate tests and inspections.
  - c. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - d. Facilities for storage and field curing of test samples.
  - e. Delivery of samples to testing agencies as applicable.
  - f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - g. Security and protection for samples and for testing and inspecting equipment at Project site.
7. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- a. Schedule times for tests, inspections, obtaining samples, and similar activities.
8. All Work by Contractor will be subject to Owner's inspection and testing at all locations and at reasonable times before acceptance of the Work. Owner's inspection and testing will be for the sole benefit of the Owner and does not:
- a. Relieve Contractor of responsibility for providing adequate quality control measures.
  - b. Relieve Contractor of responsibility for damaged to or loss of material, products, equipment, or related Work prior to final acceptance.
  - c. Constitute or imply acceptance.
  - d. Affect the continuing rights of Owner after acceptance of the completed Work.
9. The presence or absence of the Owner's quality assurance personnel does not relieve Contractor from performing Work in accordance with Contract requirements
- B. Contractor Quality Control
1. The Contract requires the Contractor to provide the required quality assurance and quality control services to ensure compliance with the Contract Documents
  2. Maintain an adequate quality assurance and control system, performing inspections and testing necessary to ensure Work conforms to Contract Documents.
  3. Maintain complete inspection record, logs, test reports, pre-installation reports, and other related records and make them available to Owner and Engineer.
  4. The CQC system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the contract Documents. The CQC system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, suppliers, fabricators, manufacturers, testing agencies, and other entities.
  5. Definitions
    - a. Quality Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
    - b. Quality Control Services: Tests, inspections, procedures, and related actions

- during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.
- c. Contractor Quality Program (CQC): The means by which the Contractor ensures that the construction, to include that performed by subcontractors, suppliers, and manufacturers, complies with the requirements of the Contract.
  - d. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.
  - e. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
  - f. Material Testing: Tests and inspections that are performed by an Nationally Recognized Testing Laboratory, an National Voluntary Laboratory Accreditation Program, or a testing agency qualified to conduct material testing and acceptable to authorities having jurisdiction, to establish material performance and compliance with industry standards.
  - g. Source Quality Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
  - h. Field Quality Control Testing: Tests and inspections that are performed onsite for installation of the Work and for completed Work.
  - i. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
  - j. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - k. Using a term such as "carpentry" does not imply that accredited or unionized individuals of a corresponding generic name, such as "carpenter", must perform certain construction activities. It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
  - l. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
6. Conflicting requirements
- a. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
  - b. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation



may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

7. Submittals
  - a. For testing agencies specified to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
  - b. CQC Plan: Submit not later than 30 days after receipt of Notice to Proceed.
  - c. CQC Report: Submit, weekly, an original and one copy in report form.
8. Test and Inspection Log
  - a. Prepare a record of tests and inspections. Include the following:
    - 1) Date test or inspection was conducted.
    - 2) Description of the Work tested or inspected.
    - 3) Date test or inspection results were transmitted to Engineer.
    - 4) Identification of testing agency or special inspector conducting test or inspection.
  - b. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.
9. Repair and Protection
  - a. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  - b. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
  - c. When included comply with the Contract Document requirements for SECTION 01 31 00 PROJECT ADMINISTRATION.
  - d. Protect construction exposed by or for quality control service activities.
  - e. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.
10. Quality Control Submittals
  - a. Submittals shall comply with the requirements of SECTION 01 32 33 PROJECT DOCUMENTATION. The CQC manager and staff shall first review all submittals for compliance with the Contract Documents. Make any required corrections, noting any deviations. Provide the required justification for deviations.
  - b. CQC manager and staff shall maintain a submittal log showing status of submittals.
11. Final Inspection and Punch List
  - a. CQC manager and staff shall conduct an inspection of the Work at the completion of all work or any milestone. This inspection will precede any final inspection by the Owner and Engineer.
  - b. Prior to requesting final inspection by the Owner and Engineer, the Contractor

shall accomplish the following:

- 1) CQC manager and staff shall develop a punch list of non-conforming items. The punch list shall be included in the CQC Report, along with the estimated date by which the items will be corrected.
  - 2) Following corrective action by Contractor, a second inspection shall be made to ascertain that all deficiencies have been corrected. Then notify the Engineer and Owner.
  - c. The Owner and Engineer, along with the Contractor, shall perform a Final Inspection of the Project. These inspections, along with correction of any deficiencies, shall be accomplished within the time stated for completion of the Work or particular increment thereof.
12. Close Out Documents
- a. The CQC manager and staff will assemble and prepare the Closeout Documents and As-Built Documents required to complete the Project closeout in accordance with SECTION 01 32 33 PROJECT DOCUMENTATION.
13. Quality Assurance
- a. Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
  - b. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
  - c. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
  - d. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
  - e. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.
  - f. Testing Agency Qualifications:
    - 1) Laboratory facilities, including personnel, and equipment, utilize shall meet the criteria detailed in ASTM E329 "Specification for Agencies Engaged in Construction Inspection and/or Testing", ASTM D3666 "Practice for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials," and ASTM D3740 "Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction."
    - 2) Testing Agency shall be accredited by the American Association of

Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHT)), or other nationally recognized testing laboratory according to 29 CFR 1910.7.

- 3) Comply with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
- g. Factory Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- h. Mockups: If applicable, before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
  - 1) Build mockups in location and of size indicated or, if not indicated, as directed by Engineer.
  - 2) Notify Engineer seven days in advance of dates and times when mockups will be constructed.
  - 3) Demonstrate the proposed range of aesthetic effects and workmanship.
  - 4) Obtain Engineer's approval of mockups before starting work, fabrication, or construction. Allow seven days for initial review and each re-review of each mockup.
  - 5) Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6) Demolish and remove mockups when directed, unless otherwise indicated.

#### 1.5 PROJECT IDENTIFICATION SIGN

- A. Provide Project Identification Sign and other temporary signs. Sign shall be installed at the NE 36<sup>th</sup> Street Project entrance. Unauthorized signs are not permitted. Project Identification Sign shall be 8 foot wide by 4 foot high, constructed of ¾-inch exterior high-density overlaid plywood. Sign shall bear the Name of Project, Owner, Contractor, and other participating agencies. Lettering shall be black applied on a white background by an experienced sign painter. Paint shall be exterior grade enamel. A sample Project Sign is included in the Appendix of Division 00.

#### 1.6 TEMPORARY UTILITIES AND FACILITIES

- A. Temporary Utilities
  1. Install temporary service.
  2. Provide temporary sewer and drainage utilities for lawful removal from site.
  3. Install water service and distribution piping in sizes and pressures adequate for construction and acceptable to Owner.
  4. Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

5. Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
6. Provide temporary ventilation and humidity control required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
7. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
8. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
9. Provide temporary telephone service in common use facilities for use by all construction personnel. Provide a directory at each telephone, listing the name and business telephone number of:
  - a. Contractor and all subcontractors employed at work site.
  - b. Owner's representatives.
  - c. Engineer's representative.
  - d. Medical Services; Physicians, Hospitals, and Ambulance service companies.
  - e. Emergency numbers of all utilities.
  - f. Police.
  - g. Fire Departments.
10. Provide temporary electronic communication service, including internet and electronic mail in field offices.
11. Cost or use charges for temporary utilities shall be included in the Contract Sum. Allow for the use of utilities by other entities without cost, including, but not limited to Owner's representative, Engineer when onsite, testing agencies, and authorities having jurisdiction.
  - a. Water from Owner's existing water system is available for purchase and use. Provide connections and extensions of services as required for construction operations.
  - b. Electric power shall be obtained by Contractor, with Contractor responsible for obtaining meter and paying for all use charges. Provide connections and extensions of services as required for construction operations. Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
  - c. Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
  - d. Installer of each permanent or temporary service shall assume responsibility for operation, maintenance, and protection of each service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

B. Temporary Facilities

1. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
2. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
3. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
4. At the Contractor's option, furnish, equip, and maintain a Contractor Field Office at the site for Contractor's use. The Contractor Field Office shall have weather-tight construction, doors with locks and convenience outlets, air conditioning, ventilation and heating, electric lighting, and telephones. Contractor Field Office shall have a room large enough and furnishings to be able to hold Project Meetings.
5. Provide storage sheds for products in conformance with the General Conditions. The storage sheds shall have weather-tight construction, heating, ventilating and air conditioning as required to comply with the General Conditions, sufficient space to provide for inspection, and electric lighting.
6. Properly store and protect equipment delivered to the job site until installation in accordance with manufacturer's recommendations. Motor space heaters shall be connected, shafts rotated, etc. All equipment shall be stored on skids or blocking, off the ground.
7. Construct and maintain temporary roads and paved areas adequate for construction operations and access to field offices. When possible, locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
  - a. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
  - b. Prepare subgrade and install subbase and base for temporary roads and paved areas according to SECTION 31 05 00 EARTHWORK MATERIALS.
  - c. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
  - d. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
8. Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with SECTION 01 31 00 PROJECT ADMINISTRATION for progress cleaning requirements.
9. Provide a first aid station in Contractor's field office. Provide full complement of first aid supplies in weatherproof container at first aid station.
10. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

- a. Materials and facilities that constitute temporary facilities are property of Contractor, except as noted elsewhere. Owner reserves right to take possession of Project identification signs.
- b. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements.

## 1.7 TRAFFIC CONTROLS

- A. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
  - 3. Construction traffic shall be controlled to minimize impact of normal plant traffic.
  - 4. Contractor shall repair damage to plant and public roadways.
  - 5. Provide signs warning of a construction site entrance.
  - 6. Provide flagman when excessive construction traffic is expected.
- B. Provide temporary parking areas for construction personnel.
- C. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
- D. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
- E. Remove snow and ice as required to minimize accumulations.
- F. Provide temporary, directional signs for construction personnel and visitors.
- G. Maintain and touchup signs so they are legible at all times.

## 1.8 ENVIRONMENTAL CONTROLS

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- C. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- D. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

- F. The Contractor shall be responsible for eliminating and/or alleviating dust resulting from his construction operations. This is particularly applicable to dust which results from vehicular traffic traveling along or through areas where construction has resulted in dirt or dust being left on roadways. The Contractor shall sprinkle water or use other dust control methods which will reduce dust to a minimum. The Owner may request additional dust control sprinkling at any time as deemed necessary. Dust control will be considered subsidiary to construction and no separate measurement and payment will be made.

#### 1.9 SECURITY AND PROTECTION FACILITIES

- A. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Resident Project Representative with one set of keys.
- B. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
- E. Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- F. Maintain facilities in good operating condition until removal.
- G. Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- H. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are property of Contractor, except as noted elsewhere. Owner reserves right to take possession of Project identification signs.
  - 2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements.
- I. Neither the Contractor nor any of his employees shall be allowed to carry firearms on the Project, either on their persons or within their automobiles. Any violation of this requirement will result in the permanent removal from the Project of the employee committing the violation.

- J. The Contractor shall remove from the site any materials found to be damaged, and any materials not meeting the specifications. These materials shall be removed promptly, unless the Engineer will accept the materials after repairing. Materials found to be damaged, or not acceptable to the Engineer, shall be removed. Examination before installation shall not relieve the Contractor from any responsibility to furnish good quality materials.
- K. Fire Protection:
  - 1. Furnish and maintain onsite adequate firefighting equipment capable of extinguishing incipient fires. UL rated; with class and extinguishing agent as required by locations and classes of fire exposures. Comply with applicable parts of National fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).
  - 2. Provide portable fire extinguishers, rated 2A minimum, at Contractor's and Engineer's field office, and at storage sheds.
  - 3. Ensure that internal combustion engine powered equipment is located a safe distance from combustible materials.
  - 4. Prohibit smoking in locations and operations of potential fire hazard and clearly post "No Smoking" or "Open Flame" signs.
  - 5. Store flammable/combustible liquids in conformance with requirements of federal and local codes and regulations and prohibit storage of flammable/combustible liquids near exits, stairways or common passageways. Provide approved metal safety containers for storage of flammable/combustible liquids in excess of 1 gallon.
- L. Surplus equipment or material, which is removed by the Contractor as specified in the plans and specifications, shall become the property of the Contractor. The Contractor shall be responsible for the disposal of salvage material offsite. Equipment and material designed to be salvage shall be transported by the Contractor to a location as directed by the Owner's Representative.

#### 1.10 ARCHEOLOGICAL DISCOVERIES

- A. No activity, which may affect a State Archeological Landmark, is authorized until the Owner has complied with provisions of the Antiquities Code of Oklahoma. The Owner has previously coordinated with the appropriate agencies and impacts to known cultural or archeological deposits have been avoided or mitigated. However, the Contractor may encounter unanticipated cultural or archeological deposits during construction.

#### 1.11 ENDANGERED SPECIES

- A. No activity is authorized that is likely to jeopardize the continued existence, or a threatened, or endangered species as listed, or proposed for listing, under the Federal Endangered Species Act (ESA), and/or the State of Oklahoma Parks and Wildlife Code on Endangered Species, or to destroy or adversely modify the habitat of such species.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**



**SECTION 01 33 10  
SUPPLIER'S SUBMITTALS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The EQUIPMENT SUPPLIER shall submit descriptive information to:
  - 1. Advise the OWNER whether the materials and equipment proposed for the project are in general conformance with the design concepts and in conformance with the Contract Documents and Specifications.
  - 2. Provide a record for the OWNER of the materials and equipment which have been incorporated into the project.
  - 3. Provide a guide for operations and maintenance of equipment.
  - 4. Provide information required for the administration of the Contract for construction of the project. This section of the specifications provides a more detailed description of the requirements for submittals as outlined in the Special Conditions.
  - 5. The CONTRACTOR will make available to the OWNER and ENGINEER all submittals over an Internet-Based Construction Management System for documentation and tracking.
- B. Additional submittals associated with the bidding process shall be provided as specified in Division 0 Documents.

**1.2 REFERENCES**

- A. Drawings and general provisions of the Contract, including Special Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections
  - 1. All other Contract Documents for specific requirements for demonstration and training for products in those Sections.

**1.3 SUPPLIER'S RESPONSIBILITIES**

- A. The EQUIPMENT SUPPLIER shall be responsible for the accuracy and completeness of the information contained in each submittal and shall insure that the values, material, equipment, or method of work shall be as described in the submittal. The following responsibilities will be assigned to the CONTRACTOR: All submittals must be stamped by the CONTRACTOR, indicating that they have been checked by the CONTRACTOR for compliance with the Contract Documents and approved by the CONTRACTOR, or contain certifications as required by the Contract Documents. Submittals that do not have the stamp applied or include the required certifications will be returned without processing to the CONTRACTOR.
- B. The EQUIPMENT SUPPLIER shall insure that there is no conflict with other submittals and notify the ENGINEER of each case where the proposed change may affect the work of another EQUIPMENT SUPPLIER or OWNER. The EQUIPMENT SUPPLIER in coordination with the CONTRACTOR shall insure coordination of submittals among the related crafts and subcontractors. Submittals will not be accepted from sub-contractors.

## PART 2 - PRODUCTS

### 2.1 MARKING OF SUBMITTALS

- A. A number shall be assigned to each submittal provided to the ENGINEER to allow each submittal to be tracked while processing through the review procedures. The CONTRACTOR will assign the numbers on the Internet-Based Construction Management System.
- B. Assignment of numbers shall be by means of a letter prefix, a sequence number, and letter suffix to indicate resubmittals.
- C. The sequence number shall be issued in chronological order for each type of submittal. Resubmittals shall be followed by a letter of the alphabet to indicate the number of times a submittal has been sent to the ENGINEER for processing. As an example, a submittal with the number 25 indicates that the submittal is the 25th submitted. Submittal number 25.1 indicates the submittal is being submitted for the second time.
- D. Correct assignment of numbers is essential as different submittal types are processed in different ways. Some submittals received do not require that any response be given for the material. A log of submissions to allow the processing of SUPPLIER's submittals will be maintained by the CONTRACTOR and ENGINEER on the Internet-Based Construction Management System and will be monitored. Logs will be reviewed periodically to determine that all submittals are received and processed.
- E. Submittals shall be marked to show clearly the applicable sections of the specification and sheet number of drawings.
- F. Submittals shall be accompanied by a Submittal Transmittal Form to be provided by the ENGINEER or through the Internet-based Construction Management System. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate discrete sections, etc. for which a submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that they should be checked as a unit.

### 2.2 DEVIATIONS FROM CONTRACT DOCUMENTS

- A. Any change in the contract documents that is requested will be initiated by the EQUIPMENT SUPPLIER issuing a Contract Modification Request or by ENGINEER issuing a Proposed Contract Modification on the form provided by the ENGINEER. The EQUIPMENT SUPPLIER's Modification Request shall fully identify and describe the deviations and state the reason the change is requested. Any savings in cost related to the substitution is to be stated in the request for consideration. Modification requests will be considered and if found acceptable will be incorporated in a Field Order or Change Order as a change to the CONTRACTOR's scope in accordance with the General Conditions.

### 2.3 SHOP DRAWINGS

- A. Definition:
  - 1. Shop drawings consist of all drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the EQUIPMENT SUPPLIER to illustrate some portion of the work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams, and other information prepared by a supplier and submitted by EQUIPMENT SUPPLIER to illustrate material or equipment for some portion of the Work.

2. Shop drawings shall indicate the kind, exact model, size, arrangement, and operation of component materials and devices; materials of construction, external connections, anchorages and supports required; performance characteristics; dimensions, weights, and other information required for installation and correlation with other materials and equipment.
- B. Schedule for Submittal of Shop Drawings:
1. The EQUIPMENT SUPPLIER shall provide schedule information so that the CONTRACTOR can submit a schedule indicating the time and sequence in which Shop Drawings are to be submitted. This schedule shall take into consideration time for delivery and a reasonable time for review of shop drawings. Proposed order and delivery dates shall be incorporated in the Progress Schedule.
  2. Shop drawings will generally be reviewed in the order in which they are received. Drawings marked "Priority" will be reviewed ahead of other shop drawing submittals not so marked which have already been received but are not yet being reviewed. EQUIPMENT SUPPLIER shall be aware that checking of "Priority" shop drawings may delay the review of other drawings which have already been submitted by the EQUIPMENT SUPPLIER and the use of this designation is to be used with discretion.
- C. Contractor's Review and Certification:
1. The CONTRACTOR shall verify that the material and equipment in each shop drawing conforms to the requirements of the Contract Documents. Shop drawings shall comply with the Contract Documents and shall bear an executed statement to that effect by the CONTRACTOR. Shop Drawings without this stamp applied will be returned without review.
- D. Requirement for Complete Shop Drawings:
1. Material in shop drawings shall be in sufficient detail to demonstrate compliance with all requirements of the Contract Documents. Shop drawings shall address material and/or methods of construction, design criteria, performance characteristics, and Special Conditions of the Specifications.
  2. Shop drawings for systems and related equipment shall include information for all components required for a complete and operational system, including electrical, mechanical, and any other information required to indicate how the various components of the system function, and shall be included in the same submittal.
  3. Where statements of certification, written guarantees, extended service agreements or extended warranties as defined in Paragraph I are required, they will be provided with the shop drawing. The effective date of the guarantee and service agreements, however, shall not be until the date specified in the Contract Documents.
  4. Shop drawings shall be clearly marked to show the applicable sections of the specifications and sheet in the drawings. Other identification may also be required on drawings such as layout drawings or schedules to allow the reviewer to determine where a particular item is to be used in the project.
  5. A minimum of two (2) hard-copies of each shop drawing shall be submitted and one electronic copy of the shop drawing shall be posted on the Internet-Based Construction Management System in PDF format. All review comments on shop drawings by the ENGINEER or OWNER shall be posted on the Internet-Based Construction Management System in PDF format on either a review comment form or comments on the shop drawing.

6. Shop drawings which do not have all of the information required for evaluation will be returned without benefit of review and comment.
- E. Review of Shop Drawings:
1. The ENGINEER will review the data for general conformity to the Contract Documents. Comments will be made on items called to the attention of the ENGINEER for review and verification. Markings will be based on this examination and do not constitute a blanket review of the shop drawing. The ENGINEER's review does not relieve the EQUIPMENT SUPPLIER from any responsibility for errors or deviations from the Contract requirements. Shop drawings which contain substantial error or omissions, or which are not clearly legible, will be returned without benefit of review.
  2. Shop drawings will be marked in one of the four following ways:
    - a. Reviewed: Shop drawings are acceptable without correction and may be distributed for construction and/or manufacture.
    - b. Furnish as Corrected: Shop drawings are acceptable with minor corrections as marked and may be used with the corrections noted.
    - c. Revise and Resubmit: Shop drawings having significant errors or incomplete data shall be revised and resubmitted for subsequent review after corrections have been made or additional materials are available.
    - d. Rejected: Material or equipment described is not acceptable.
- F. Approval of Equal Substitutions
1. Where Contract Documents allow substitution of material or equipment as an approved equal to the specified product, shop drawings shall be provided. Shop drawings shall include supporting data to indicate specifically, on a point-by-point basis for each feature of the design, how the proposed product is equal to or better than the specified product. Deviations from the Contract Documents must be requested and approved as described in Article 2.3 of this Section.
- G. Shop Drawings Required
1. Shop drawings are required for all items of equipment or materials where submittals are listed in the individual specification section and for the determination of substitutions for approval as described in Paragraph F of this Article. Only these shop drawings will be reviewed. Shop drawings which are not required may be submitted for "Record Purposes" but may not be reviewed.
- H. Owner Selected Options
1. Where selections are to be made by the OWNER for color, texture or finish and shop drawings are required for that product, shop drawings will be submitted for approval of the materials of construction, composition, etc., prior to the selection of finishes by the OWNER. Items requiring selection of finish for which shop drawings are not required shall be furnished as record data. Information shall be provided as soon as possible to allow OWNER adequate time to consider available options for selection. Color chips, samples, etc., for all items are to be assembled and submitted to the OWNER through the ENGINEER for selection of finishes at the same time to allow all options to be considered and allow selections to be coordinated with other items of finish. The ENGINEER will meet with the OWNER who will determine the finish to be used within 2 weeks, unless additional samples are required for selection. Materials for which shop drawings are required are to be submitted for approval of material

quality prior to selection of finish.

I. Certifications, Warranties, and Other Requirements:

1. Where indicated in the Contract Documents the following items as defined below are to be provided as part of the shop drawing:
  - a. Certified Test Report - A report prepared by an approved testing agency on the results of tests performed on materials to indicate their compliance with the specifications. Reports are to be numbered consecutively for reference. Retest required to verify compliance with Contract Documents shall be identified with the same number as the original test with a letter to indicate retest, similar to the numbering system used for Shop Drawings.
  - b. Certification of Local Field Service - A certified letter stating that field service is available from a factory or supplier approved service organization located within an 8-hour drive of the project site or closer as required by the individual technical specifications.
  - c. Extended Warranty - A guarantee of performance for the product or system beyond the warranty described in section 01 78 36-PS Warranties. The Warranty Certificate is to be issued in the name of the OWNER.
  - d. Extended Service Agreement - A contract to provide operations and maintenance for equipment as specified beyond that required to full requirements for warranty repairs; or to perform routine maintenance at some period beyond the warranty period. The Service Agreement is to be issued in the name of the OWNER.
  - e. Certification of Adequacy of Design - A certified letter from the manufacturer of the equipment stating that they have designed the equipment offered to account for structural stability to withstand all imposed loads without deformation, failure or adversely affecting the operational requirements of the unit; and operational capability, including mechanical and electrical equipment sizing to be fully operational in accordance with the conditions specified.
  - f. Certification of Applicator/Subcontractor Qualifications - A certified letter stating that the applicator/subcontractor proposed to perform a specified item of work is duly designated as factory-authorized and trained for the application or installation of the specified product.

2.4 RECORD DATA

- A. Record data shall be submitted to provide information as to the general character, style and manufacturer of the equipment to allow the OWNER to adequately identify the materials or equipment incorporated into the project. Record data shall be provided for all equipment and materials of construction for items for which Shop Drawings are not required.
- B. Record data shall be complete to indicate where the material was incorporated into the project, provide schedules of materials and their use, colors, model numbers and other information which would allow this material to be replaced at some future date. Record data will be received by the ENGINEER and logged for transmittal to the OWNER. Record data will not be reviewed for comment and no response will be made to the EQUIPMENT SUPPLIER.

## 2.5 OPERATIONS AND MAINTENANCE MANUALS

- A. For each type of equipment to be furnished and installed under this Contract, the EQUIPMENT SUPPLIER shall prepare an operation and maintenance manual covering:
1. Name, address, and telephone number of nearest competent service organization who can supply parts and service.
  2. Equipment function, normal operating characteristics, and limiting conditions, which reflect "as-built" conditions for the equipment furnished.
  3. Assembly, installation, alignment, adjustment, and checking instructions, including field modification made during installation, startup and testing.
  4. Operating instructions for startup, routine and normal operation, regulation and control, backwash, clean-in-place, shutdown, and emergency conditions.
  5. Preventative maintenance schedule including lubrication and maintenance instructions with quantities and scheduled intervals.
  6. Guide to "troubleshooting".
  7. Parts lists, and predicted life of parts subject to wear. Include spare parts inventory, special storage requirements, and a vendor contact list.
  8. Outline, cross-section, and assembly drawings; engineering data; control schematics and point-to-point electrical and instrumentation wiring diagrams, and reproductions of all equipment nameplates.
  9. Factory test data and performance curves for equipment where factory tests are specified.
  10. Line-by-line programming logic for all programmable logic controllers.
  11. Safety considerations.
- B. The operation and maintenance manuals shall be provided with a table of contents and each individual section shall be separated with a tab for easy reference.
- C. The above information, as applicable, shall be provided for the equipment as indicated in individual specification sections.
- D. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- E. Manuals shall be printed on heavy, first quality paper, 8-1/2 x 11 inch size with standard 3-hole punching. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches. Where reduction is not practicable, larger drawings shall be folded separately, and placed in envelopes which are bound into the manual. Each envelope shall bear suitable identification on the outside.
- F. One electronic copy of each manual shall be submitted to the ENGINEER no later than 60 days prior to equipment startup. After review by the ENGINEER, EQUIPMENT SUPPLIER shall prepare four (4) final copies of each operation and maintenance manual and deliver to the ENGINEER not later than 90 days after to placing the equipment into operation. The final manuals shall be bound in stiff three ring binders of appropriate size, but maximum 3-1/2-inch capacity. A copy of the final manual shall be provided in PDF format on CD-ROM or USB drive and submit on Internet-Based Construction Management System.
- G. All information in the manuals shall be in the English language, with dimensions in US units.

## 2.6 REQUESTS FOR INFORMATION

- A. When it is necessary for the EQUIPMENT SUPPLIER to request additional information, interpretation of the Contract Documents, or when the EQUIPMENT SUPPLIER believes there is a conflict between the drawings and specifications, he shall identify the conflict and request clarification through the CONTRACTOR using the Request for Information form. Use of this form will allow requests for information to be routed to OWNER, design engineers, design consultants or others through the ENGINEER and allow these requests to be monitored to determine that clarification is provided when needed. Sufficient information shall be attached to permit a written response without further information.
- B. The ENGINEER will log each request and will review the request to determine that the information provided is adequate. If information is not adequate, the request will be returned for additional information. When adequate information is provided, the request will be reviewed and a response made. If a change is required, the ENGINEER will initiate a Proposed Contract Modification. If no change is required the ENGINEER will provide additional information required to help the EQUIPMENT SUPPLIER comply with the Contract Documents.

## 2.7 SCHEDULE OF VALUES AND PAYMENT ESTIMATES

- A. Payment procedures shall be as described in the front-end documents. For contracts based on lump sum amounts with multiple equipment items, the CONTRACTOR is to submit to the ENGINEER for approval, a breakdown of cost for the Project. The breakdown is to provide adequate detail to allow easy determination of the percentage of completion for partial delivery payment review by the ENGINEER. Specification sections and add or deduct items in the proposal are to be used as a guide for preparing the breakdown. This breakdown is to be incorporated onto a form for the submission of payment request provided by the ENGINEER or in a form approved by the ENGINEER.
- B. The CONTRACTOR is to submit a schedule showing the anticipated schedule of payments for the CONTRACTOR to assist the OWNER in determining when funds are to be made available for payment of periodic payment requests. The EQUIPMENT SUPPLIER shall coordinate with the CONTRACTOR as necessary to provide this schedule.

## 2.8 EQUIPMENT INSTALLATION REPORT

- A. A written report shall be submitted by the EQUIPMENT SUPPLIER performing the installation check for all major equipment. This report shall certify that: 1) The equipment has been properly installed and lubricated, 2) is in accurate alignment, 3) is free from any undue stress imposed by connecting piping, equipment, or anchor bolts, and 4) has been operated under full load conditions and that it is operating satisfactorily. The report shall also indicate if and what operator training and maintenance instruction was provided and for what specific equipment. A sample form is attached.

## 2.9 NOTIFICATION BY SUPPLIER

- A. Written notification of the need for testing, observation work by ENGINEER, or intent to work outside of regular working hours, or the request to shut down the facilities or make utility connections shall be given to the ENGINEER by issuance of a Notification By CONTRACTOR on a form provided by the ENGINEER.

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**



**SECTION 01 45 00**  
**QUALITY CONTROL**

**PART 1 - GENERAL**

**1.1 QUALITY ASSURANCE ACTIVITIES BY THE OWNER AND THE CONTRACTOR**

- A. Quality assurance activities of the Owner through their own forces or through contracts with materials testing laboratories and survey crews are for the purpose of monitoring the results of the Contractor's work to see that it is in compliance with the requirements of the Contract Documents. Failure on the part of the Owner or Engineer to perform or test products or constructed works in no way relieves the Contractor of the obligation to perform work and furnish materials conforming to the Contract Documents.
- B. The Owner will pay for the following testing performed in the field: soil compaction, proctors, soil or aggregate gradations, and concrete sampling and testing. The Contractor shall provide testing for proposed materials such as backfill material types and gradations, riprap quality and gradation, concrete mix designs, and all other testing specified and not being performed by the Owner.

**1.2 CONTRACTOR'S RESPONSIBILITIES**

- A. Control the quality of work produced and verify that the work performed meets the standards of quality established in the Contract Documents.
  - 1. Inspect the work performed by the Contractor, subcontractors, and suppliers. Correct defective work.
  - 2. Inspect products to be incorporated into the project. Provide only those products that comply with the Contract Documents.
  - 3. Verify conformance of the work and products with the Contract Documents before notifying the Owner of need for testing.
  - 4. Provide consumable construction materials of adequate quality to provide a finished product that complies with the Contract Documents.
  - 5. Provide and pay for the service of an approved professional materials testing laboratory to ensure that products proposed for use fully comply with the Contract Documents.
  - 6. Perform tests as indicated in this and other sections of the specifications. Schedule the time and sequence of testing with the Owner and Engineer. Testing is to be observed by the Owner, Engineer, or designated representative.
  - 7. Provide labor, materials, tools, equipment, and related items for testing by the Owner including, but not limited to temporary construction required for testing and operation of new and existing utilities.
- B. Provide Certified Test Reports as applicable on products or constructed works to be incorporated into the project as required by Section 01 33 10, SUBMITTALS. Reports are to indicate that products or constructed works are in compliance with the Contract Documents.
- C. Provide and maintain a written Quality Control Program that establishes the methods of assuring compliance with the Contract Documents.
- D. Designate Quality Control personnel at the start of the project. These personnel shall have the authority to monitor the work effectively and to implement and enforce the Quality

Control program.

- E. Assist the Engineer, Owner, and Owner's testing organization to perform quality assurance activities.
  - 1. Provide access to the work and to the Manufacturer's operation at all times work is in progress.
  - 2. Cooperate fully in the performance of sampling, inspection, and testing.
  - 3. Furnish labor and facilities to:
    - a. Provide access to the work to be tested.
    - b. Obtain and handle samples for testing at the project site or at the source of the product to be tested.
    - c. Facilitate inspections and tests.
    - d. Store and cure test samples.
  - 4. Furnish copies of the tests performed on products.
  - 5. Provide adequate quantities of representative product to be tested to the laboratory at the designated location.
  - 6. Give the Owner adequate notice before proceeding with work that would interfere with testing.
  - 7. Notify the Engineer and the testing laboratory prior to the time that testing is required. Lead time is to be adequate to allow arrangements to be made for testing.
  - 8. Do not proceed with any work until testing services have been performed and results of tests indicate that the work is acceptable.
  - 9. Provide complete access to the site and make Contract Documents available.
  - 10. Provide personnel and equipment needed to perform sampling or to assist in making the field tests.
  - 11. Testing performed by the Owner will be paid for by the Owner. If tests fail, Contractor shall reimburse the Owner for cost of re-testing once corrections are made.
- F. Provide a recognized testing laboratory capable of performing a full range of testing procedures complying with the standards or testing procedures specified. Obtain Owner's approval for the testing laboratory before testing is performed.
- G. Provide personnel certified to perform the test required.
- H. Should the requirements of this Section of the specification conflict with the requirements of the detailed specifications, the technical specifications shall govern.

### 1.3 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 10, SUBMITTALS, and shall include:
  - 1. The name of the proposed testing laboratory along with documentation of qualifications, a list of tests that can be performed, and a list of recent projects for which testing has been performed with references from those projects.
  - 2. Test reports per Paragraph 1.07, TEST REPORTS of this specification.

### 1.4 STANDARDS

- A. Provide a testing laboratory that complies with the ACIL (American Council of Independent Laboratories) "Recommended Requirements for Independent Laboratory Qualifications".

- B. Perform testing per recognized test procedures as listed in the various sections of the specifications, standards of the State Department of Highways and Public Transportation, American Society of Testing Materials (ASTM), or other testing associations. Perform tests in accordance with published procedures for testing issued by these organizations.

#### 1.5 DELIVERY AND STORAGE

- A. Handle and protect test specimens of products and construction materials at the construction site in accordance with recognized test procedures.

#### 1.6 VERIFICATION TESTING

- A. Provide verification testing when tests performed by the Owner indicate that materials or the results of construction activities are not in conformance with Contract Documents.
- B. Verification testing is to be provided at the Contractor's expense to verify products or constructed works are in compliance after corrections have been made.
- C. Tests must comply with recognized methods or with methods recommended by the Owner's testing laboratory and approved by the Engineer.

#### 1.7 TEST REPORTS

- A. Test reports are to be prepared for all tests.
  - 1. Tests performed by testing laboratories may be submitted on their standard test report forms. These reports must include the following:
    - a. Name of the Owner, project title and number, equipment installer and general contractor.
    - b. Name of the laboratory, address, and telephone number.
    - c. Name and signature of the laboratory personnel performing the test.
    - d. Description of the product being sampled or tested.
    - e. Date and time of sampling, inspection, and testing.
    - f. Date the report was issued.
    - g. Description of the test performed.
    - h. Weather conditions and temperature at time of test or sampling.
    - i. Location at the site or structure where the test was taken.
    - j. Standard or test procedure used in making the test.
    - k. A description of the results of the test.
    - l. Statement of compliance or non-compliance with the Contract Documents.
    - m. Interpretations of test results, if appropriate.
  - 2. Submit reports on tests performed by Contractor or his suppliers or vendors.
- B. Distribute copies of the test reports through the Internet Based Construction Management system, Section 01 31 24.

#### 1.8 NON-CONFORMING WORK

- A. Immediately correct any work that is not in compliance with the Contract Documents or submit a written explanation of why the work is not to be corrected immediately and when the corrective work will be performed.

- B. Payment for non-conforming work shall be withheld until work is brought into compliance with the Contract Documents.

#### 1.9 LIMITATION OF AUTHORITY OF THE TESTING LABORATORY

- A. The testing laboratory representative are limited to providing consultation on the test performed and in an advisory capacity.
- B. The testing laboratory is not authorized to:
  1. Alter the requirements of the contract documents.
  2. Accept or reject any portion of the work.
  3. Perform any of the duties of the Contractor.
  4. Stop the work.

### PART 2 - PRODUCTS

#### 2.1 TESTING APPARATUS

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

### PART 3 - EXECUTION

#### 3.1 PROTECTIVE COATINGS

- A. Test protective coatings per specifications in Division 09 FINISHES.

#### 3.2 LEAKAGE TESTS FOR STRUCTURES

- A. Test structures that will contain water on a full time or intermittent basis for leaks. Perform tests prior to installing equipment or materials within the basins. In the event that the basins fail to pass the test, drain the basin, repair the leaks, re-fill, and re-test the basin. Repeat tests until the basin passes the test. The Owner may repeat the test at any time during the one (1) year guarantee period.
- B. Test the basin for leakage using the following procedure:
  1. Determine the evaporation allowance for loss of water.
    - a. Use a standard circular pan procedure established by the U.S. Weather Bureau to measure evaporation rate.
    - b. Calculate evaporation allowance by multiplying the evaporation rate in gallons per 24 hours per square foot of surface are by the open surface area of the water in the basin.
  2. Calculate the allowable leakage for the basin. Allowable leakage is calculated as 0.03 gallons per square foot of concrete area in contact with the water per 24 hours.
  3. Fill the basin to the overflow level with water at a rate not to exceed 2' per hour.
  4. Allow the basins to set for three (3) days.
  5. Observe the perimeter of the basin and identify all leaks.
  6. Repair basin walls and floors where leaks have been identified.
  7. Mark the water level at the basin wall. Measure the fall in water level over a 24-hour period to the nearest 1/8" at least twice a day to determine the quantity of water lost. Provide a stilling well for measurement if required to allow accurate measurement.
  8. Calculate the amount of water lost during this time period.

9. Compare the amount of water lost to the allowable loss.
- C. Drain the basin, determine the sources of leakage and repair if the amount of water lost exceeds the allowable leakage plus the evaporation allowance.

### 3.3 PIPING SYSTEMS

#### A. Test Requirements

1. Perform test on piping systems including piping installed between or connected to existing pipe.
2. Conduct tests on buried pipe to be hydrostatically tested after the trench is completely backfilled. If field conditions permit and if approved by the Engineer, partially backfill the trench and leave the joints open for inspection and conducting of the initial service leak test. Do not conduct the acceptance test until backfilling is complete.
3. Pneumatically test the buried piping and expose joints of the buried piping for the acceptance test.
4. Conduct the test on exposed piping after the piping is completely installed, including supports, hangars, and anchors, but prior to installation.
5. Do not perform testing on pipe with concrete thrust blocking until the concrete has cured at least five (5) days.
6. Determine and remedy the cause of the excessive leakage for any pipe failing to meet the specified requirements for water or air tightness.
7. Tests must be successfully completed and reports filed before piping is accepted. File test reports through the Internet Based Construction Management system, Section 01 31 24.
8. Submit the plan for testing to the Engineer for review at least 10 days before starting the test.
9. Remove and dispose of temporary blocking material and equipment after completion and acceptance of the piping test.
10. Repair any damage to the pipe coating.
11. Clean pipelines so that they are totally free flowing prior to final acceptance.
12. Test piping independently from tests on structures.
13. Test method and test pressure depend upon the application of the piping.
  - a. Pressure pipe is defined as piping that is part of a pumped or pressurized system. Perform test for pressure pipe per the procedures indicated in Paragraph B of this section.
  - b. Gravity pipe is defined as piping that depends upon the force of gravity for flow through the pipe, with the exception of process piping described in Paragraph D. Perform test for gravity pipe per the procedures indicated in Paragraph C, D, or E of this section.
  - c. Chemical processing lines are to be tested as pressure pipe regardless of the operating conditions. The test pressure is to be 1.5 times the pressure rating of the pipe.
  - d. Process piping between hydraulic structures is to be considered as pressure pipe. Perform the test for this pipe per Paragraph B of this section. The test pressure is to be the maximum hydrostatic head plus 10'. The maximum

hydrostatic head is the difference in elevation of the pipe at its lowest point and the maximum top of the wall elevation of the hydraulic structure on the piping system.

B. Pressure And Leakage Tests Of Pressure Piping

1. Perform hydrostatic pressure and leakage tests using methods, and per performance requirements of Section 4 of AWWA C-600.
  - a. The pressure required for hydrostatic pressure test shall be 50% above the normal working pressure. If the normal working pressure cannot be determined, use the pipe pressure rating as the normal working pressure.
  - b. Provide temporary plugs and blocking necessary to maintain the required test pressure. Where piping is cast in the walls for a structure, brace the walls prior to testing as required to prevent load of test pressure from being imposed upon the structure.
  - c. Provide corporation cocks at least 3/4" in diameter, pipe riser, and angle globe valves at each pipe dead-end in order to bleed air from the line.
  - d. Duration of pressure test shall be at least 24 hours.
2. Perform a separate leakage test after the pressure test.
  - a. Perform test at maximum operating pressure as determined by the Engineer for a duration of not less than two (2) hours.
  - b. Repair any visible leaks regardless of the total leakage shown by the test.
  - c. Repair pipelines which fails to meet the test and retest as necessary until the results conform to the test requirements.
  - d. Remove and replace defective materials, pipes, valves, and accessories.
  - e. Test the pipelines in sections by shutting valves or installing temporary plugs as necessary.
  - f. Fill the pipeline with water and remove the air.
  - g. Maintain the test pressure in the pipe for the entire test period by means of a force pump.
  - h. Accurately measure the water required to maintain the pressure. The amount of water required is a measure of the leakage.

3. The maximum allowable leakage is determined by the following formula:

$$L = \frac{S * D * P^{\frac{1}{2}}}{133,200}$$

- a. L = the allowable leakage in gallons per hour
  - b. S = the length of pipe tested in feet
  - c. D = the nominal diameter of the pipe in inches
  - d. P = the test pressure in pounds per square inch gauge.
  - e. Leakage is defined as the volume of water provided to maintain the test pressure after the pipe has been filled with water, the air expelled and the pipe brought to test pressure.
4. Pipe with visible leaks or leakage exceeding the maximum allowable leakage is considered defective and must be corrected.

C. Hydrostatic Leak Test

1. Perform hydrostatic leak tests after backfilling.
2. The length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2' or 2' above the ground water level whichever is higher and the head over the downstream crown is not more than 6'.
3. Plug the pipe by pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.
4. Continue the test for one (1) hour and make provisions for measuring the amount of water required to maintain the water at a constant level during this period.
5. Remove the jointing material, and remake the joint if any joint shows any visible leakage or infiltration.
6. Remove and replace any defective or broken pipes.
7. Determine the maximum allowable leakage or infiltration by the following formula:

$$L = \frac{C * D * S}{126,720}$$

- a. L = the allowable leakage in gallons per hour
  - b. S = the length of pipe tested in feet
  - c. D = the nominal diameter of the pipe in inches
  - d. C = infiltration/exfiltration rate.
    - 1) Outside of 25-year floodplain, C = 50
    - 2) Within the 25-year floodplain, C = 10
8. Determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and location are subject to the Engineer's approval.
9. Pipe with visible leaks or infiltration or exceeds the maximum allowable leakage or infiltration is considered defective and must be corrected.

D. Low Pressure Air Test

1. Use air test in lieu of the hydrostatic test if desired, or if pipeline grades do not allow filling the entire pipeline segment or manhole to the indicated depth.
2. Perform low-pressure air tests, using equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. Test is to conform to procedure described in ASTM C-828, ASTM C-924 except for testing times. The following test times are required:

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

- a. Provide the equipment with an air regulator valve or air safety valve set to an internal air pressure in the pipeline that cannot exceed 6 psig.
- b. Pass air through a single control panel.
- c. Provide pneumatic plugs that have a sealing length equal to or greater than the circumference of the pipe to be tested.
- d. Provide pneumatic plugs that resist internal test pressures without requiring external bracing or blocking.
- e. Provide an air compressor of adequate capacity for charging the system.
3. Perform air test only on lines less than 36" diameter. Air tests for pipes larger than 36" may be air tested at each joint.
4. Check connections for leakage with a soap solution. If leaks are found, release the air pressure, repair the leak, and retest with soap solution until results are satisfactory, before resuming air test.
5. Determine the maximum allowable time for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch.

$$T = 0.085 * \frac{D * K}{Q}$$

- a. T = the time for the pressure to drop 1.0 pound per square inch gauge in seconds
- b. K = 0.000419\*D\*L, but not less than 1.0
- c. D = the average inside diameter in inches



- d. L = the length of line of the same pipe size in feet
  - e. Q = the rate of loss, shall be 0.0015 cubic feet per minute per square foot of internal surface.
- E. Air Test For Individual Joints
- 1. Lines 36" and larger may be tested at individual joints.
  - 2. The maximum allowable time for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge is 10 seconds for all pipe sizes.
- F. Deflection Testing For Pipe
- 1. Perform deflection tests on flexible and semi-rigid pipe in accordance with ASTM 3034.
    - a. Two tests will be performed. The initial testing will be performed a maximum of 800 feet behind pipe laying operations.
    - b. The maximum allowable deflection of pipe measured as the reduction in vertical inside diameter is 3.0% unless specified otherwise.
    - c. Conduct second deflection test after the final backfill has been in place a minimum of 60 days.
    - d. Thoroughly clear the lines before testing.
  - 2. Perform test by pulling a properly sized mandril through the line.
  - 3. Excavate and repair pipe with deflections in excess of the maximum allowable deflection.
- G. Manhole Testing
- 1. Test manholes for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, vacuum testing or other approved methods acceptable to TCEQ per 217.58. Vacuum testing requires a vacuum of 10 inches of mercury (4.91 psi), and a passing test requires that for 2 minutes the vacuum pressure does not reduce by more than 1 inch of mercury (0.49psi loss maximum). Make manhole watertight and re-test if the manhole fails the leakage test. The maximum leakage for hydrostatic testing is 0.025 gallons per foot diameter per foot of manhole depth per hour. Prepare for hydrostatic exfiltration testing by sealing all wastewater lines coming into the manhole with an internal pipe plug, then fill the manhole with water and maintain full for at least one hour. With concrete manholes a period of 24 hours prior to testing may be used in order to allow saturation of the concrete.
- H. Tests For Plumbing Drainage And Vent Systems
- 1. Plug openings as necessary.
  - 2. Test drainage and venting systems by filling piping with water to the level of the highest vent stack for 30 minutes.
  - 3. Make the examination for leakage at joints and connections.
  - 4. There shall be no drop in water level.

**END OF SECTION**

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**SECTION 01 57 00**  
**TEMPORARY STORM WATER POLLUTION CONTROL**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Provide labor, materials, equipment and incidentals necessary to construct temporary facilities to provide and maintain control over environmental conditions at the Site. Remove temporary facilities when no longer needed.
- B. Construct temporary impounding works, channels, diversions, furnishing and operation of pumps, installing piping and fittings, and other construction for control of conditions at the Site. Remove temporary controls at the end of the Project.
- C. Provide a Storm Water Pollution Prevention Plan in accordance with Oklahoma Pollutant Discharge Elimination System (OPDES) Construction General Permit (OKR10), file required legal notices and obtain required permits prior to beginning any construction activity.
- D. Comply with all requirements of the Permit, including the development of a SWPPP, filing of the Notice of Intent (NOI) and Notice of Termination (NOT), record maintenance, and posting of the Permit.
- E. Provide labor, materials, equipment, and incidentals necessary to prevent storm water pollution for the duration of the Project. Provide and maintain temporary erosion and sediment control measures to prevent soil erosion and discharge of soil-bearing water runoff to adjacent properties and walkways.
- F. Remove pollution control structures when no longer required to prevent storm water pollution and restore and stabilize areas disturbed during removal.

**1.2 QUALITY ASSURANCE**

- A. Construct storm water pollution prevention measures prior to the beginning of construction and maintain these during construction until final stabilization has been achieved for the area protected.
- B. Plan and conduct all land-disturbing activities to minimize the area to be exposed at any one time. Minimize the time of exposure, off-site erosion, sedimentation, and adverse water quality impacts.
- C. Manage surface water runoff originating upstream of an exposed area to minimize erosion and sediment loss during the period of exposure.
- D. Install measures to control both the velocity and rate of release so as to minimize erosion and sedimentation of the receiving water body (i.e., ditch, channel, stream) in accordance with regulatory requirements and as directed by the Owner, Construction Manager or the Engineer.
- E. Periodically clean out and dispose of all sediment and other pollutants as necessary to maintain the treatment capacity of each pollution control feature. Clean out and properly dispose of all sediment and other storm water pollutants at the time of completion of the Work.

**1.3 SUBMITTALS**

- A. Provide copies of notices, records and reports required for Record Data in accordance with

## SECTION 01 32 33 PROJECT DOCUMENTATION.

### 1.4 STANDARDS

- A. Provide a storm water pollution prevention plan that complies with Local, State, and Federal requirements. Comply with all requirements of the Oklahoma Department of Environmental Quality (ODEQ) Construction General Permit OKR10 for storm water discharges from construction activities under the OPDES program.

### 1.5 PERMITS

- A. Post a copy of the Construction Site Notice at the construction site in a location where it is readily available for viewing by the general public and Local, State, and Federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.
- B. Maintain copies of a schedule of major construction activities, inspection reports, and revision documentation with the storm water pollution prevention plan (SWPPP) required under the OKR10 for Storm Water Discharges from Construction Activities for all projects.
- C. Submit the following to the ODEQ and the Operator of any Municipal Separate Storm Sewer System (MS4) receiving construction site discharge from the Site:
  - 1. Notice of Intent (NOI) at least 14 days prior to beginning construction activity. Construction activity may commence 24 hours after the submittal of an electronic NOI.
  - 2. Notice of Change (NOC) letter when relevant facts or incorrect information was submitted in the NOI, or if relevant information in the NOI changes during the course of construction activity.
  - 3. Notice of Termination (NOT) when the construction project has been completed and stabilized.
- D. Post a copy of the NOI at the construction site in a location where it is readily available for viewing by the general public and Local, State, and Federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.
- E. Maintain copies of a schedule of major construction activities, inspection reports, and revision documentation with the storm water pollution prevention plan (SWPPP) required under the OPDES General Construction Permit (OKR10) for Storm Water Discharges from Construction Activities for all projects.

### 1.6 POLLUTION CONTROL

- A. Prevent the contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations. Provide adequate measures to prevent the creation of noxious air-borne pollutants. Prevent dispersal of pollutants into the atmosphere. Do not dump or otherwise discharge noxious or harmful fluids into drains or sewers, nor allow noxious liquids to contaminate public waterways in any manner.
- B. Provide equipment and personnel and perform emergency measures necessary to contain any spillage.
- C. Contain chemicals in protective areas and do not dump on soil. Dispose of such materials at off-Site locations in an acceptable manner.

- D. Excavate contaminated soil and dispose at an off-Site location if contamination of the soil does occur. Fill resulting excavations with suitable backfill and compact to the density of the surrounding undisturbed soil.
- E. Provide documentation to the Owner which states the nature and strength of the contaminant, method of disposal, and the location of the disposal Site.
- F. Comply with local, State and Federal regulations regarding the disposal of pollutants.
- G. Groundwater or run-off water which has come into contact with noxious chemicals, sludge, or sludge-contaminated soil is considered contaminated. Contaminated water must not be allowed to enter streams or water courses, leave the Site in a non-contained form or enter non-contaminated areas of the Site.
- H. Pump contaminated water to holding ponds constructed by the Contractor for this purpose, or discharge to areas on the interior of the Site, as designated by the Engineer.
- I. Construct temporary earthen dikes or take other precautions and measures as required to contain the contaminated water and pump to a designated storage area.
- J. Wash any equipment used for handling contaminated water or soil within contaminated areas three times with uncontaminated water prior to using such equipment in an uncontaminated area. Dispose of wash water used to wash such equipment as contaminated water.

#### 1.7 EARTH CONTROL

- A. Stockpile excess soil and other earth not required for backfill at the time of generation in location shown on drawings. Control stockpile material to eliminate interference with Contractor and Owner's operations. Provide silt fence around stockpile to prevent run off of soil. Keep spoil material separate from excess soil stockpile.
- B. Dispose of excess earth and spoil material. Pay cost for disposal unless otherwise noted. Provide written approval by the property owner for all disposal on private property, and approval by the Owner if such disposal affects the use of Site or other easements.

#### 1.8 MAINTENANCE OF WATER

- A. Manage water resulting from rains or ground water at the site. Maintain trenches and excavations free of water at all times. Provide and maintain pumps as necessary to remove excess water. Direct water away from the site to prevent damage to surrounding property.
- B. Manage water during construction to make the construction site workable. Prepare and submit a Water Management Plan for approval. The plan shall describe:
  - 1. Methods to be used to manage water at the site.
  - 2. Contingency plans for heavy rains or floods.
  - 3. Procedures to be used in the event of emergencies.
- C. Perform operations necessary to control water at the site. Lower the water table in the construction area by acceptable means if necessary to maintain the site in a dry and workable condition at all times. Provide drains, sumps, casings, well points, and other water control devices as necessary to remove excess water.
- D. Maintain standby equipment to provide proper and continuous operation for water management. Monitor the operation on a 24-hour basis to provide continuous operation.

- E. Modify Water Management Plan as required by the Engineer. In the event of failure of the system, flooding of the excavation may be ordered by the Engineer until the system is returned to service.
- F. Ensure that water drainage does not damage adjacent property. The Contractor shall be responsible for the discharge of water from the site.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Provide materials meeting regulatory requirements.

## PART 3 - EXECUTION

### 3.1 CONSTRUCTING, MAINTAINING AND REMOVING TEMPORARY CONTROLS

- A. Construct temporary controls in accordance with regulatory requirements such as TXR150000.
- B. Maintain controls in accordance with regulatory requirements where applicable, or in accordance with the requirements of the Contract Documents.
- C. The Contractor shall have the sole responsibility for the means, methods, techniques, sequences, and procedures for furnishing, installing and maintaining the erosion and sedimentation control system.
- D. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- E. Remove temporary control when no longer required, but before the Project is complete. Correct any damage or pollution that occurs as the result of removing controls before the point where they are no longer required.

**END OF SECTION**

**SECTION 01 60 00**  
**PRODUCT REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard; product substitutions; and comparable products.

**1.2 REFERENCES**

- A. Preselection Drawings and general provisions of the Contract, including Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Definitions
  - 1. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
    - a. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
    - b. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
    - c. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
  - 2. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 3. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

**1.3 ADMINISTRATIVE REQUIREMENTS – NOT USED**

**1.4 SUBMITTALS**

- A. See Section 01 33 10 "Supplier's Submittals" for requirements.

## 1.5 COMPARABLE PRODUCTS

- A. If the Specification states that's an Engineer Approved Equal is allowed. Identify product or fabrication or installation method. Include Specification Section number and title and Drawing numbers and titles.
  - 1. ENGINEER'S Action: If necessary, ENGINEER will request additional information or documentation for evaluation within one week of receipt of a comparable product submittal.

## 1.6 QUALITY ASSURANCE

- A. Design Requirements: Where design is specified; design of installation, systems, equipment, and components, including supports and anchorage, shall be in with provisions of International Building Code by International Code Council. Refer to the drawings for required design load criteria.
- B. Environmental Requirements: Provide products suitable for installation and operation under rated conditions at 830 feet above sea level. Products installed outdoors or in unheated enclosures shall be capable of continuous operation within an ambient temperature range of 10°F to 110°F.
- C. Product installations are defined as equipment furnished for an individual facility installed as part of a single project. Multiple equipment items installed as part of the same project shall not be considered multiple installations. Multiple equipment items installed at the same facility at different times as part of different projects can be considered multiple installations.

## 1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- C. Storage:
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.



4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Off-site storage of materials and equipment shall be the sole responsibility of the CONTRACTOR.

## 1.8 SITE CONDITIONS

- A. The equipment, sizes, materials, and arrangements described in this section are based on recommendations by equipment suppliers and shall be considered minimum limits of acceptability. The EQUIPMENT SUPPLIER shall be responsible for design, arrangement, and performance of all equipment supplied under this section.
- B. Environmental Conditions:
  1. All equipment including controls and drives specified herein shall be specifically designed to be installed for this service and the environment encountered in this installation, unless noted otherwise.
  2. The environment will be moist, and corrosive, exhibiting hydrogen sulfide and other corrosive gases encountered in municipal wastewater treatment plants.
  3. All equipment shall be designed and capable of operation outdoors at ambient temperatures of 10°F to 110°F.
  4. Equipment shall be compatible with heat tracing and insulation, which will be furnished and installed by the CONTRACTOR. EQUIPMENT SUPPLIER shall design piping systems with ample clearances and material compatibility to accept required heat tracing and insulation. If additional freeze protection beyond heat tracing and insulation is required it shall be furnished by the EQUIPMENT SUPPLIER. EQUIPMENT SUPPLIER shall coordinate with the CONTRACTOR to provide direction on where heat tracing is required, and shall verify that the CONTRACTOR has provided adequate heat tracing and insulation during startup activities.

## 1.9 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to OWNER.
  2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for OWNER.

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Like items of products furnished and installed shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions.
  4. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.
  5. OWNER reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  6. Where products are accompanied by the term "as selected," ENGINEER will make selection.
  7. Where products are accompanied by the term "match sample," sample to be matched is ENGINEER'S.
  8. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
  9. Regulatory Requirements: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
  10. Safety Guards:
    - a. Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal.
    - b. Use 16-gauge or heavier; galvanized steel, aluminum, coated steel and ½-inch mesh expanded steel.
    - c. For outdoor installations prevent entrance of rain or dripping water.
  11. Electrical Components: Provide Work in accordance with NFPA 70, National Electrical code, and be labeled by a nationally recognized testing laboratory or other agency acceptable to the authority having jurisdiction.
  12. Equipment Finish:
    - a. Provide manufacturer's standard finish and color, except where specific color is indicated.
    - b. If manufacturer does not have a standard color, provide color as approved by ENGINEER.
  13. Special Tools and Accessories: Provide to OWNER all special tools and accessories required placing equipment in operation. These include, but not limited to, adequate oil and grease (as required for first servicing of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special

tools, and other spare parts required for maintenance.

14. Lubricant: Provide initial lubricant recommended by manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, start-up, and operation until final acceptance by OWNER.

B. Fabrication and Manufacture:

1. General Requirements:

- a. Manufacture parts to U.S.A. standard sizes and gauges.
- b. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
- c. Design structural members for anticipated shock and vibratory loads.
- d. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
- e. Modify standard products as necessary to meet performance specifications.

2. Lubrication System Requirements:

- a. Require no more than weekly attention during continuous operation.
- b. Convenient and accessible. Oil drains, with bronze or stainless steel valves, and fill-plugs easily accessible from normal operating area or platform. Locate drains to allow convenient collection of oil during changes without removing equipment from its installed position.
- c. Provide constant-level oilers or oil level indicators for oil lubrication systems.
- d. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

C. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that comply with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system.
8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles,

dimensions, and other characteristics that are based on the product named.

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches ENGINEER'S sample. ENGINEER'S decision will be final on whether a proposed product matches.
  - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product that complies with other specified requirements.
  - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, ENGINEER will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
  - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, ENGINEER will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

- A. See applicable sections for specific requirements.
- B. Schedule:
  1. Ensure shipment and delivery occurs concurrent with shipment of product.
  2. Transfer to OWNER upon acceptance by CONTRACTOR of shipment.
- C. Packaging and Shipment:
  1. Package and ship items to avoid damage during long term storage in original cartons or in appropriately sized, hinged-cover, wood, plastic or metal boxes.
  2. Prominently display on each package: Part number, consistent with Operation and Maintenance Manual identification system; equipment description, quantity of parts; and equipment manufacturer.
- D. Deliver to designation location as directed by Resident Project Representative.

## PART 3 - EXECUTION

### 3.1 WORK IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS

- A. When the specification Section requires the Work to be accomplished in accordance with "manufacturer's instructions", obtain and distribute copies of such instructions to parties involved in the installation. Provide two copies to the Resident Project Representative and maintain one set at the Project site.
- B. Handle, install, connect, clean, condition and adjust products in strict accordance with the manufacturer's instructions and in conformity with the Contract Documents. Do not omit any preparatory step or installation procedures. In case of conflict between job conditions or Contract Documents with manufacturer's instructions notify Resident Project Representative.
- C. Upon completion of installation, obtain Certificate of Installation from manufacturer's

representative.

### 3.2 INSPECTION

- A. Inspect products for signs of pitting, rust decay, or other deleterious effects of storage. Do not install products showing such effects. Remove damaged product from Project site and expedite delivery of identical new product. Delays to Work resulting from product damage, which necessitates procurement of new product, will be considered delays within CONTRACTOR'S control.

### 3.3 INSTALLATION

- A. Drawings show general locations for product installation, unless specially dimensioned.
- B. No shimming between machined surfaces is allowed.
- C. Install Work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Recoat finish surfaces that are damaged prior to final acceptance of Work.
- E. Do not cut or notch any structural member or building surface without specific approval of ENGINEER.
- F. Handle, install, connect, clean, condition, and adjust product in accordance with Contract Documents and manufacturer's instructions.
- G. Apply field coating in accordance with Contract Documents.
- H. Perform required adjustments, tests, operation checks, and other start-up activities.
- I. Fill lubricant reservoirs and replace consumption during testing, start-up, and operation prior to final acceptance of Work by OWNER.

**END OF SECTION**



# SUBSTITUTION REQUEST (After the Bidding Phase)

Project: \_\_\_\_\_ Substitution Request Number: \_\_\_\_\_  
 \_\_\_\_\_ From: \_\_\_\_\_  
 To: \_\_\_\_\_ Date: \_\_\_\_\_  
 \_\_\_\_\_ A/E Project Number: \_\_\_\_\_  
 Re: \_\_\_\_\_ Contract For: \_\_\_\_\_

Specification Title: \_\_\_\_\_ Description: \_\_\_\_\_  
 Section: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
 Trade Name: \_\_\_\_\_ Model No.: \_\_\_\_\_  
 Installer: \_\_\_\_\_ Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History:  New product  2-5 years old  5-10 yrs old  More than 10 years old

Differences between proposed substitution and specified product: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Point-by-point comparative data attached - REQUIRED BY ENGINEER

Reason for not providing specified item: \_\_\_\_\_  
 \_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Engineer: \_\_\_\_\_  
 Address: \_\_\_\_\_ Owner: \_\_\_\_\_  
 \_\_\_\_\_ Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work:  No  Yes; explain \_\_\_\_\_  
 \_\_\_\_\_

Savings to Owner for accepting substitution: \_\_\_\_\_ (\$ \_\_\_\_\_).

Proposed substitution changes Contract Time:  No  Yes [Add] [Deduct] \_\_\_\_\_ days.

Supporting Data Attached:  Drawings  Product Data  Samples  Tests  Reports

# SUBSTITUTION

## REQUEST

(Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: \_\_\_\_\_

Signed by: \_\_\_\_\_

Firm: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: \_\_\_\_\_

Attachments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### A/E's REVIEW AND ACTION

- Substitution approved - Make submittals in accordance with Specification Section 01 33 10.
- Substitution approved as noted - Make submittals in accordance with Specification Section 01 33 10.
- Substitution rejected - Use specified materials.
- Substitution Request received too late - Use specified materials.

Signed by:

Date:

Additional Comments:  Contractor  Subcontractor  Supplier  Manufacturer  A/E  \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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**SECTION 01 75 25**  
**EQUIPMENT TESTING AND STARTUP**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. EQUIPMENT SUPPLIER's scope of work to be performed under this specification shall be to support installation, testing and startup of all supplied equipment systems.

**1.2 REFERENCES – NOT USED**

**1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Service of EQUIPMENT SUPPLIER's Representative
  1. EQUIPMENT SUPPLIER's contracted cost for the equipment shall include the cost of furnishing competent and experienced personnel who shall represent the manufacturers and shall assist the CONTRACTOR, when required, to renovate or install, adjust, and test the equipment in conformity with the Contract Documents.
  2. After the equipment is placed in permanent operation by the CONTRACTOR, EQUIPMENT SUPPLIER's personnel shall make all adjustments and tests required to prove that such equipment is in proper and satisfactory operating condition and shall instruct the OWNER's representatives in the proper operation and maintenance of such equipment or system. Training must be adequate and acceptable to OWNER's representative. The preliminary Equipment O&M must be approved prior to start of training.

**1.4 SUBMITTALS**

- A. Submit to ENGINEER, for review, start-up and test schedule a minimum of 60 days prior to commencing Work specified in this section.
- B. Submit to ENGINEER an electronic copy and a minimum of two (2) hard copies of field test data and test records for all equipment and systems.

**PART 2 - PRODUCTS**

- A. CONTRACTOR shall furnish and install initial supply of oil, grease or other consumable required per EQUIPMENT SUPPLIER's instructions to startup, test and place into service the supplied equipment.

**PART 3 - EXECUTION**

**3.1 TESTING AND STARTUP PLAN**

- A. Submit a plan that includes a schedule for testing and startup of all equipment and systems provided as part of the Work. Specific Tests for each piece of equipment are detailed in the Equipment Specification Section.
- B. Include in the startup plan:
  1. Sequences.
  2. Lock-out procedures and safety precautions.
  3. Utility requirements.
  4. Related items and piping which must be complete and the schedule for completion.

5. Instrumentation settings.
  6. Operation Support
- C. EQUIPMENT SUPPLIER shall provide a schedule and outline for training of OWNER's personnel. Equipment shall not be turned over to OWNER prior to training of OWNER's personnel. Specifically identify adjustment and maintenance items that must be done in initial 30-day period.

### 3.2 PREPARATION

EQUIPMENT SUPPLIER shall verify that the CONTRACTOR has performed the following work prior to testing and startup:

- A. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions.
- B. Remove temporary bracing supports and other construction debris that may damage equipment.
- C. Remove protective coatings and oils from new equipment used for protection during shipment and installation.
- D. Flush and fill lubricated systems in equipment in accordance with Manufacturer's instructions.
- E. On new equipment, install temporary connections and devices required to fill, operate, checkout and drain the system.
- F. Check equipment for correct direction of rotation and freedom of moving parts.
- G. Align equipment to Manufacturer's tolerances.
- H. Check installation prior to start-up for conformance to Manufacturer's instructions.
- I. Adjust or modify equipment to make equipment properly operational.
- J. Correct any deficiencies or problems noted in Manufacturer's representative's installation reports.
- K. Complete testing of related piping systems and furnish test reports to ENGINEER.

### 3.3 TESTING AND STARTUP

SUPPLIER shall perform the following:

- A. EQUIPMENT SUPPLIER with CONTRACTOR assistance as required shall begin checkout, testing, and startup procedures after training of OWNER's personnel and approval by ENGINEER of testing and startup plan. EQUIPMENT SUPPLIER's installation report shall be submitted within 48 hours of startup.
- B. Make final connections to equipment and complete the system installation necessary to apply the system loads to the equipment and verify the equipment functions correctly.
- C. Perform all tests as required by the specifications prior to startup.
- D. Start equipment according to manufacturer's instructions.
- E. Place each piece of equipment in the system in operation until the entire system is functioning.

- F. Operate the system through the design performance range consistent with available flows. Adjust, balance, and calibrate and, in general, check out the equipment, safety devices, controls, and process system to operate within the design conditions.

**END OF SECTION**

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**SECTION 01 78 23**  
**OPERATION AND MAINTENANCE DATA**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Emergency manuals.
  - 3. Operation manuals for systems, subsystems, and equipment.
  - 4. Maintenance manuals for the care and maintenance of systems and equipment.

**1.2 REFERENCES**

- A. Drawings and general provisions of the Contract, including Special Conditions and Division 01 Specification Sections, apply to this Section.
- B. Definitions
  - 1. Preliminary Data: Initial and subsequent submissions for ENGINEER'S review.
  - 2. Final Data: ENGINEER accepted data, submitted as specified herein.
  - 3. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
  - 4. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
  - 5. Subsystem: A portion of a system with characteristics similar to a system.
  - 6. Instructional Manual: Equipment and Operating Data submitted prior to the testing and startup of the equipment, subsystem, or system.
  - 7. Operation and Maintenance Data: The operation and maintenance data submitted to be included in the Operation and Maintenance Manual for the Project.
- C. Related Sections
  - 1. Section 01 33 00 "Supplier's Submittals" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Section 01 70 00 "Demonstration and Training" for submitting operation and maintenance manuals.
  - 3. All other Contract Documents for specific operation and maintenance manual requirements for the Work in those Sections.

**1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Sequencing and Scheduling
  - 1. Equipment and System Data (Instructional manual):
    - a. Preliminary Data:
      - 1) Do not submit until ENGINEER has approved Shop Drawings.
      - 2) Submit prior to shipment date.

- b. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing. Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.
- B. Coordination
  - 1. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

#### 1.4 SUBMITTALS

- A. Initial Submittal: Submit draft copy of each Operation and Maintenance Data (Manual) at least 60 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. ENGINEER will return one copy of draft and mark whether general scope and content of Manual is acceptable.
- B. Final Submittal: Submit one (1) copy of each Manual in final form at least 30 days before requesting inspection for Substantial Completion. ENGINEER will return copy with comments within 21 days of receipt or notify CONTRACTOR it's accepted.
  - 1. Correct or modify each manual to comply with ENGINEER'S comments. Submit (4) copies of each corrected manual within 21 days of receipt of ENGINEER'S comments. Provide three (3) electronic copies of the final manual in PDF format.

### PART 2 - PRODUCTS

#### 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
  - 1. List of documents.
  - 2. List of systems.
  - 3. List of equipment.
  - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically or by treatment area as directed by ENGINEER. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system or by treatment area as directed by ENGINEER. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents.

#### 2.2 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
  2. Table of contents.
  3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
1. Subject matter included in manual.
  2. Name and address of Project.
  3. Name and address of OWNER.
  4. Name, address, and telephone number of CONTRACTOR.
  5. Name and address of ENGINEER.
  6. Subcontractor, Supplier, Manufacturer, Installer, or Maintenance Contractor's name, address, and telephone number, as appropriate.
    - a. Identify area of responsibility of each.
    - b. Provide name and telephone number of local source of supply for parts, replacement, and service.
  7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. \_\_\_ OF \_\_\_", Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
    - c. Text: Manufacturer's printed data, or neatly typed.
    - d. Three-hole punch data for binding and composition; arrange printing so punched holes do not obliterate data.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Manual.
  3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic

software diskettes for computerized electronic equipment.

4. Supplementary Text: Prepared on 8-1/2-by-11-inch 20-POUND MINIMUM, white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
  - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
  - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
6. Electronic Media Format:
  - a. Portable Document format (PDF)
    - 1) After all preliminary data has been found to be acceptable, submit operational and maintenance data in PDF format on CD-ROM or USB drive.
    - 2) Files to be exact duplicates of accepted preliminary data. Arrange by specification Section number. Bookmark sections.
    - 3) Files to be fully functional and viewable in most recent version of Adobe Acrobat.
  - b. Manufacturer's Standard Electronic Format:

### 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  1. System, subsystem, and equipment descriptions.
  2. Performance and design criteria.
  3. Operating standards.
  4. Operating procedures.
  5. Operating logs.
  6. Wiring diagrams.
  7. Control diagrams.
  8. Piped system diagrams.
  9. Precautions against improper use.
  10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
  1. Product name and model number.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.



8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identifies color-coding where required for identification.

#### 2.4 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
  2. Manufacturer's name.
  3. Color, pattern, and texture.
  4. Material and chemical composition.
  5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
  2. Types of cleaning agents to be used and methods of cleaning.
  3. List of cleaning agents and methods of cleaning detrimental to product.
  4. Schedule for routine cleaning and maintenance.
  5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

## 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - 1. Standard printed maintenance instructions and bulletins.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training videotape, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
  - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: If applicable, include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances

and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

## PART 3 - EXECUTION

### 3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
  1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
  1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
  1. Do not use original Project Record Documents as part of operation and maintenance manuals.
  2. Comply with requirements of newly prepared Record Drawings in Section 01 78 39 "Project Record Documents."
- G. Comply with schedule for submitting operation and maintenance documentation.
- H. Maintenance Summary:
  1. Compile individual Maintenance Summary Form for each applicable equipment item, respective unit or system and for components or sub-units.
  2. Format:
    - a. Use Maintenance Summary Form include with this Section as a guide.
    - b. Use only 8-1/2 by 11-inch size paper.

3. Include detailed lubrication instructions and diagrams showing parts to be greased or oiled,; recommended type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
  - a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished with the Operation and Maintenance Data.
  - b. "Unit" is the unit of measure for ordering part.
  - c. "Quantity" is the number of units recommended.
  - d. "Unit Cost" is the current purchase price.

### 3.2 DATA FOR MATERIALS AND FINISHES

- A. Content for Architectural Products, Applied Materials, and Finishes:
  1. Manufacturer's data, giving full information on products:
    - a. Catalog number, size, and composition.
    - b. Color and texture designations.
    - c. Information required for reordering special-manufactured products.
  2. Instructions for Care and Maintenance:
    - a. Manufacturer's recommendation for types of cleaning agents and methods.
    - b. Cautions against cleaning agents and methods that are detrimental to product.
    - c. Recommended schedule for cleaning and maintenance.
- B. Content for Moisture Protection and Weather Exposed Products:
  1. Manufacturer's data, giving full information on products:
    - a. Applicable standards.
    - b. Chemical composition.
    - c. Details of installation.
  2. Instructions for inspection, maintenance, and repair.

### 3.3 SUPPLEMENTS

- A. Sample forms included after "End of Section" are considered part of this Section.
  1. Maintenance Summary Form.

**END OF SECTION**

**MAINTENANCE SUMMARY FORM**

PROJECT: \_\_\_\_\_ CONTRACT NO: \_\_\_\_\_

EQUIPMENT ITEM: \_\_\_\_\_

MANUFACTURER: \_\_\_\_\_

EQUIPMENT TAG NOS.: \_\_\_\_\_

WEIGHT OF INDIVIDUAL COMPONENTS (Over 100 Pounds) \_\_\_\_\_

NAME PLATE DATA (HP, Voltage, Speed, etc.): \_\_\_\_\_

Manufacturer's Local Representative:

Name: \_\_\_\_\_ Telephone No. \_\_\_\_\_

Address: \_\_\_\_\_

<b>Maintenance Operation Requirements</b>	<b>Frequency</b>	<b>Lubricant</b>
List briefly each maintenance operation required and refer to specific information in manufacturer's maintenance manual, if applicable. Also note tools needed for each maintenance operation and safety considerations.	List frequency of each maintenance operation.	Refer by symbol to lubricant required.

**MAINTENANCE SUMMARY FORM (Continued)**

LUBRICANT LIST

Reference Symbol	Mfgr _____	Mfgr _____	Mfgr _____
List symbols used in maintenance requirements	List equivalent lubricants of several manufacturers'		

RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Price

**SECTION 01 78 36**  
**WARRANTIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
1. Preparation and submittal of warranties.
  2. Time and schedule of submittals.
  3. Transfer of Maintenance responsibility.

**1.2 REFERENCES**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Sections, apply to this Section.
- B. Related Sections:
1. Section 01 33 10 "Supplier's Submittals"
  2. Section 01 75 25 "Equipment Testing and Startup."
  3. Section 01 78 23 "Operation and Maintenance Data"
  4. Drawings and general provisions of the Contract, including Special Conditions and Division 01 Specification Sections, apply to this Section.
  5. Warranties required for specific products or work included in individual technical specification Sections.

**1.3 SUBMITTALS**

- A. At the end of the project furnish the following warranty summary:
1. Provide two copies of all warranty information in an electronic format on a compact disk (CD) or USB Flash drive.
  2. Provide one copy of all warranty information in a commercial quality 8 1/2 x 11-inch three-ring hardback, plastic binder.
  3. CDs and binder shall be labeled WARRANTIES with current year, project name, contractor name and telephone number, and equipment supplier name and telephone number.
  4. Prepare table of contents in the same sequence as the manual submitted per Section 01 78 23 "Operation and Maintenance Data."
  5. Separate each warranty with index tab sheets keyed to the table of contents listing.
  6. Behind each index sheet, or within each warranty file, include an information sheet labeled WARRANTIES, with current year, project name, contractor name and telephone number, subcontractor name and telephone number, equipment supplier name and telephone number, manufacturer name and telephone number, and applicable Section number and title.
- B. Preparation
1. Warranty shall be on the company's original forms signed by authorized agent only.
  2. No warranty shall start prior to equipment being put into operation.
  3. Verify that documents are in proper form, contain full information, and are notarized.

4. Co-execute submittals when required.
  5. Retain warranties until time specified for submittal.
  6. All of the above shall be included in each submittal.
- C. Conditions
1. Warranty date of beginning shall be the date of Substantial Completion as determined by the applicable technical specification Section. If an item does not have a separate substantial completion date, the project substantial completion data shall be used as the beginning of the warranty period.
  2. Equipment warranty period shall be for a minimum of two years from the warranty date of substantial completion, unless specifically stated otherwise.
- D. Schedule
1. Submittals shall be submitted by the CONTRACTOR in accordance with Section 01 33 10 "Supplier's Submittals."
  2. Provide the responsible subcontractors, suppliers, and manufacturers' warranties in duplicate, within ten days after completion of the applicable item of work.
  3. Warranties shall be submitted prior to final Application for Payment.
  4. Provide a separate letter for each maintenance responsibility transference to include the mutually agreed time and date of the transfer of responsibility.

#### 1.4 SPECIAL EQUIPMENT WARRANTY

- A. Special Equipment Warranty
1. The SUPPLIER shall jointly warrant to the OWNER and CONTRACTOR that all equipment, including all components of the complete assembly furnished by it hereunder, complies in all material respects with the design and specifications of these documents and contains no defects of material or workmanship. In the event of failure of any part or parts of the equipment during the warranty period, due to defects of design, materials, or workmanship, the affected part or parts shall be replaced or repaired at SUPPLIER's option promptly upon notice by the OWNER. All replacement parts shall be furnished, delivered, and installed at the expense of the SUPPLIER.
  2. Unless specifically stated otherwise, the warranty period shall be interpreted as the 24-month period of beneficial use following substantial completion which includes the 30-day startup period and successful completion of the performance testing of the SUPPLIER-furnished equipment by the OWNER as provided below, and shall be exclusive of the time of use of the equipment in installation, testing, adjusting, etc., during the construction period, or of the time in storage, after delivery and prior to installation. All equipment shall be operated for a minimum 30-day startup period and shall successfully complete the performance testing before final acceptance and before the start of the 24-month warranty period. SUPPLIER's warranty, should CONTRACTOR be delayed, will not extend beyond five (5) years (for equipment with a 2-year warranty, extend period for equipment with longer warranties) after receipt of purchase order from the CONTRACTOR, without adjustment in contract price.
  3. If the equipment does not meet the requirements of the Specifications, the SUPPLIER shall correct or service the equipment at no additional cost to Owner, as necessary to meet the specified requirements. In the event the equipment is unable to meet the specified requirements within the warranty period, the equipment SUPPLIER shall



- refund an amount equal to the original purchase price of the equipment.
4. The CONTRACTOR shall be responsible for insuring that the SUPPLIER's special equipment warranty is not voided by acceptance of the terms of purchase agreements between the CONTRACTOR and the SUPPLIER. In all events, the CONTRACTOR will be held ultimately responsible for enforcement of the requirements of this warranty at his expense.
  5. Payment for equipment as "Materials-On-Hand" will not be made until the OWNER receives an approved Special Equipment Warranty.

## PART 2 - PRODUCTS

### 2.1 WARRANTY CERTIFICATES

- A. The installation contractor shall complete all warranty certificates and register the product with the manufacturer.
- B. Use the date of substantial completion as the installation date.
- C. List the product model, product serial number, and any additional information required by the manufacturer on each certificate.
- D. Provide a copy of the original certificate in lieu of the original certificate in the warranty manual if the manufacturer requires the original copy in lieu of a copy.

## PART 3 - EXECUTION

### 3.1 PRODUCT WARRANTY

- A. The CONTRACTOR shall fill out all product warranty forms during the manufacturer's required time limit.
  1. Failure to do so may result in the OWNER's loss of standard product coverage in which the CONTRACTOR shall become liable for the same coverage and time limit forfeited due to their omission.
  2. The CONTRACTOR shall notify the owner, prior to installation, of all optional extended warranties provided by the manufacturer and make available to the owner the opportunity to purchase the extended warranty.
  3. The CONTRACTOR shall insure that all warranty documents, including copies of completed registration forms, are included in the closeout documents.
- B. Warranty pre-expiration equipment review
  1. The CONTRACTOR, OWNER, and ENGINEER shall conduct an on-site review of equipment and systems covered by warranties.
    - a. This review will be scheduled approximately 2-months prior to expiration of the Warranty.
    - b. The purpose of the review will be to evaluate the condition of the equipment and systems to determine if Warranty repairs of claims are necessary.
    - c. The CONTRACTOR shall cooperate to notify the issuer of the Warranty and to schedule necessary repairs or corrective actions prior to expiration of the Warranty.

**END OF SECTION**

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**SECTION 02 41 19  
SELECTIVE DEMOLITION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The Section includes demolition and removal of piping, fittings, and appurtenances to connect the sanitary sewer force main to the existing Junction Box #1 Structure.

**1.2 RELATED SECTIONS**

- A. 01 32 33 – PROJECT DOCUMENTATION
- B. 01 12 16 – CONSTRUCTION OF SEQUENCE ITEMS
- C. 09 91 00 – PAINTING AND PROTECTIVE COATINGS

**1.3 SUBMITTALS**

**A. ACTION SUBMITTALS**

- 1. Contractor shall verify the location and extent of items to be demolished prior to submitting this proposed demolition plan.

**B. INFORMATIONAL SUBMITTALS**

- 1. Extents of demolition and removal, location of capped and/or disconnected utilities, and all other pertinent information shall be shown on the Project Record documents to be delivered to the Engineer as described in SECTION 01 32 33 – PROJECT DOCUMENTATION.
- 2. Pre-demolition photographs showing existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by selective demolition operations.
- 3. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

**1.4 EXISTING CONDITIONS**

- A. All demolition procedures shall be conducted so as to minimize interference with adjacent structures and operations and access. Contractor shall provide, erect and maintain temporary barriers and safety devices as necessary.
- B. Notify Owner of discrepancies between actual existing conditions and the Plans before proceeding with selective demolition.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Contractor shall protect existing landscaping, appurtenances and structures which are not to be demolished. Contractor shall prevent the movement or settling of structures and piping adjacent to demolition areas, providing bracing and shoring as required.

**3.2 BLASTING**

- A. Explosives: Do not use explosives.

### 3.3 DEMOLITION/REMOVAL

- A. The demolition or removal of all structural components, equipment, utilities, and pipelines shall be accomplished in conjunction with the SECTION 01 12 16 – CONSTRUCTION OF SEQUENCE ITEMS, as described in the Plans, and as approved by the Owner.
- B. Piping shown on the Plans to be removed shall be removed to the limits indicated on the Plans.
- C. Electrical wiring to demolished facilities shall be disconnected at both ends and removed prior to demolition. All associated labels shall be removed. Conduits shall be cut cleanly and capped at the limit of the excavation/demolition and marked on record drawings.
- D. Equipment to be removed by the Contractor shall have anchor bolts cut off 1-inch below the concrete surface which remains. Grout shall be placed over and cutoff bolts. Existing pipe connections which are to be reused shall have flanges cleaned and new bolts and gasket sets furnished. Piping which remains, as well as sumps, trenches, etc., shall be protected during demolition activities to prevent moisture and debris from entering them. Cut ends of pipe shall be ground smooth, cleaned, and painted per SECTION 09 91 00 - PAINTING AND PROTECTIVE COATINGS to 6 inches back from cut.
- E. Where existing walls and/or slabs are to be sawcut or cored and portions removed, the openings shall be painted to protect exposed rebar unless specified otherwise on drawings.
- F. Structures, pipelines and appurtenances shall be demolished in an orderly and careful manner. If adjacent structures, piping, etc., appear to be endangered by demolition activities, Contractor shall cease operations and notify Engineer immediately. Operations shall not be resumed until corrective measures have been taken by the Contractor.
- G. Materials or equipment removed by the Contractor in conjunction with demolition or modification activities shall become the property of the Contractor unless indicated by the Owner to be returned. Contractor shall remove items to be reinstalled or retained in such a manner to prevent damage. The Contractor shall transport items to be retained at a location on the treatment plant site to be designated by the Owner. Unless otherwise noted on the Plans, demolished piping shall become the property of the Contractor and shall be promptly moved offsite.
- H. Unless otherwise noted or approved by Owner in writing, no materials shall be burned or buried on site, and no explosives shall be used for demolition.
- I. Cleaning of concrete prior to pouring concrete or grout shall be performed in accordance with Division 3 specifications.
- J. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an permitted landfill in accordance with local, state, and federal laws and regulations.

**END OF SECTION**

**SECTION 03 40 00  
PRECAST MANHOLES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section specifies manholes for waterline vaults, and other utility vaults as required and shown on the Drawings. This Section includes the following:
  - 1. Precast reinforced concrete manholes.

**1.2 RELATED SECTIONS**

- A. Section 01 45 00 "Quality Control"

**1.3 REFERENCE STANDARDS**

- A. American Association of State Highway and Transportation Officials (AASHTO):
  - 1. M 306 – Specification for Drainage Structure Castings
  - 2. HS20-44 – Truck Loading
- B. ASTM International (ASTM):
  - 1. A48 – Specification for Gray Iron Castings
  - 2. A536 – Specification for Ductile Iron Castings
  - 3. C76 – Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - 4. C150 – Specification for Portland Cement
  - 5. C443 – Specification for Concrete Pipe and Manholes, Using Rubber Gaskets
  - 6. C478 – Specification for Precast Concrete Manhole Sections
  - 7. C890 – Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
  - 8. C915 – Specification for Precast Concrete Water and Wastewater Structures
  - 9. C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
  - 10. C923 – Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
  - 11. C990 – Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
  - 12. D3753 – Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells

**1.4 SUBMITTALS**

- A. ACTION SUBMITTALS:
  - 1. Shop Drawings: For manholes: Include plans, elevations, sections, details, and attachments to other work.
  - 2. Provide design of joint or joints, including design and durometer hardness of the rubber gasket proposed.
  - 3. Provide product data for precast riser sections, covers, frames, grade rings, and pipe sleeves.
  - 4. For castings furnish manufacturer's certification stating the casting meets the proof-load testing requirements of AASHTO M306.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Manhole rings, covers, and appurtenances shall be designed to meet AASHTO M306.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Joint Materials. Store gaskets and sealants in as cool, clean, and shaded place as practicable, preferably at 70 degrees F or less. Store lubricant in accordance with manufacturer's recommended temperature range.

## PART 2 - PRODUCTS

### 2.1 PRECAST CONCRETE MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  1. Designed Precast Concrete Manholes: ASTM C913; designed according to ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
  2. Cement: ASTM C150, Type II.
  3. Diameter: 48-inches minimum, unless otherwise indicated.
  4. Base Section: 12-inches, or as shown on the Drawings.
  5. Riser Sections: Minimum wall thickness shall be as listed under Wall "B" in the "Class Tables" of ASTM C76, and lengths to provide depth indicated.
  6. Top Section: Cone type top, unless otherwise indicated in plans.
  7. Resilient Pipe Connectors: In accordance with ASTM C923, cast or fitted into manhole walls, for each pipe connection. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.
  8. Steps: Unless otherwise noted, manhole steps shall not be provided.
  9. Joints: Conform to the joint specification of ASTM C478, use rubber gaskets of the round O-ring design complying with requirements of ASTM C443. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with an approved non-shrink grout on the inside and the outside of the manhole. Grade rings shall be mortared to each other and on the inside and outside to provide a waterproof seal.
  10. Lifting Lugs: Manhole sections and cones may be furnished with lift lugs or lift holes. If lift holes are provided, they shall be plugged with a nonmetallic, non-shrink grout.
  11. Apply a bituminous damp proofing coating to the exterior surfaces of the precast manhole sections. Apply the coating to the buried portion of the precast manhole. Care shall be taken to apply the coating in accordance with manufacturers recommendations. All exposed sections of the precast manhole shall not be painted, unless otherwise indicated.
    - a. Approved manufacturers:
      - 1) Carboline – Topcoat Bitumastic 50
      - 2) Or approved equal.
  12. Grout: Non-shrink grout: Unless otherwise noted grout shall be non-shrink and in accordance with specification SECTION 03 60 00 - GROUT, NON-SHRINK.

## 2.2 MANHOLE FRAMES AND COVERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work.
- B. Construction: Unless otherwise specified or indicated on the Drawings, provide:
  - 1. Manhole Frame, Ring, and Cover:
    - a. Include indented top design with lettering cast into cover identifying service, with wording equivalent to "SANITARY SEWER", or as indicated on the Drawings.
    - b. Manhole Cover and Frame shall be watertight and the cover shall be able to be bolted to the frame.
  - 2. Material: Composite frames and covers
  - 3. Frame, ring, and cover shall meet proof-load testing requirements of AASHTO M 306.
  - 4. Frame, ring, and cover shall be powder coated black from the factory. Field applied coatings are not permitted.
  - 5. Cover shall be solid casting with no holes.
  - 6. Frame shall be bolted to the precast manhole top per manufacturer's recommendation. Install a neoprene O-ring gasket between the frame and precast concrete manhole top prior to bolting.

## 2.3 MORTAR

- A. Mortar: Furnish mortar comprised of one part Portland cement, ASTM C150, Type II, IIA, or I-II, and two parts clean sand.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Manhole Types and Requirements:
  - 1. Manholes for valves, vaults, and access points shall be precast in accordance with the Drawing requirements.

### 3.2 MANHOLE INSTALLATION

- A. Manhole Base: Construct either cast-on-site or monolithic round, precast reinforced concrete base section. The base shall have a minimum thickness indicated above and projects no less than 6-inches beyond the outside walls of the base to form a flange intended to resist uplift.
- B. Precast Manholes:
  - 1. Excavation: side clearances outside the manhole and/or structures shall be no greater than to allow for forming, connection of piping, proper application of special coatings, if required, and to permit inspection.
  - 2. Construct precast manholes of the sizes and configuration at the locations in accordance with ASTM C478 and as indicated on the Drawings.
  - 3. Apply bituminous damp proofing coating to exterior surfaces of manholes as indicated in Section 2.1.

### 3.3 TESTING

- A. Manholes shall be tested in accordance with Division 01 Section 01 45 00 "Quality Control".

#### 3.4 MANHOLE FRAMES AND COVERS

- A. Provide manhole frame and cover at the location of the type as indicated on the Drawings.
- B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops above finished surface elsewhere as indicated in Drawings.
- C. The Contractor shall submit a request to the Engineer and be approved prior to ordering any materials for the manhole. Ring hold down bolts (4 minimum) shall pass through the grade rings into the top of the cone.
- D. A manhole where personnel entry is anticipated cover shall have at least a 36-inches clear opening, unless otherwise shown on Drawings.
- E. Either adjust manhole cover and frame or adjust roadway surface to obtain a smooth transition if manhole located in roadway. Adjust surrounding grade, filling any depressions, around manhole.
- F. Remove construction debris, trash, and plugs from manhole prior to placing in service.

**END OF SECTION**



**SECTION 05 50 00  
METAL FABRICATIONS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Miscellaneous steel framing and supports.
  - 2. Structural-steel door frames.
  - 3. Miscellaneous steel trim.
  - 4. Metal ladders and safety cages.
  - 5. Alternating tread stair.
  - 6. Floor/vault/sidewalk doors or hatches.
  - 7. Metal bollards.
  - 8. Pipe guards.
  - 9. Metal floor plate and supports.
  - 10. Abrasive metal nosings, treads, and thresholds.
  - 11. Loose steel lintels.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

**1.4 SUBMITTALS**

- A. Product Data: For each product used on Project.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
  - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
  - 2. Provide templates for anchors and bolts specified for installation under other Sections.
  - 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for

their preparation.

C. Welding certificates.

## 1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following as applicable:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

## 1.7 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, which are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Ferrous Metals:

1. Steel Plates, Shapes, and Bars: ASTM A 36.
2. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316 for nonwelded items and Type 316L for welded items.

3. Rolled-Steel Floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.
  4. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
  5. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallurgically bonded to steel by a proprietary process.
    - a. Available Products:
      - 1) IKG Industries, a Harsco company; Mebac.
      - 2) W. S. Molnar Company; SlipNOT.
  6. Steel Tubing: ASTM A 500, Grade B, cold-formed steel tubing.
  7. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
  8. Slotted Channel Framing: Cold-formed metal channels complying with MFMA-3, 1-5/8 by 1-5/8 inches. Channels made from galvanized steel complying with ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.079-inch nominal thickness.
  9. Cast Iron: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.
- C. Nonferrous Metals:
1. Aluminum Extrusions: ASTM B 221, alloy 6063-T6.
  2. Aluminum-Alloy Rolled Tread Plate: ASTM B 632, alloy 6061-T6.
  3. Aluminum Castings: ASTM B 26, Alloy 443.0-F.

## 2.3 FASTENERS

- A. General: Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Expansion Anchors: Cast-in-Place Anchors in Concrete: Comply with the requirements of SECTION 05 05 23 - ANCHOR BOLTS, EXPANSION ANCHORS AND CONCRETE INSERTS.
- C. Cast-in-Place Anchors in Concrete: Comply with the requirements of SECTION 05 05 23 - ANCHOR BOLTS, EXPANSION ANCHORS AND CONCRETE INSERTS.

## 2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Compatible with the coating system selected in accordance with SECTION 09 - 91 00 PAINTING AND PROTECTIVE COATINGS.
- C. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for reglazing welds in steel.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
- E. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 - CAST-IN-PLACE CONCRETE for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

## 2.5 FABRICATION

- A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
  - 1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
  - 2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.
  - 3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
  - 4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
  - 5. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches o.c.
- B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Fabricate units from steel shapes, plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
  - 1. Fabricate steel girders for wood frame construction from continuous steel shapes. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches o.c.
  - 2. Fabricate steel pipe columns for supporting wood frame construction with steel baseplates and top plates welded to pipe with fillet welds the same size as pipe wall thickness.

## 2.6 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
  - 1. Lintels in Exterior Walls: Galvanize, where indicated.

## 2.7 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate from structural shapes and bars fully welded together, with 5/8-by-1-1/2-inch steel channel stops secured with countersunk machine screws. Reinforce frames and drill and tap as necessary to accept finish hardware. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
  - 1. Exterior Frames: Prime with zinc-rich primer.

## 2.8 MISCELLANEOUS STEEL TRIM

- A. Fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Exterior Miscellaneous Steel Trim: Galvanize where indicated.

## 2.9 METAL LADDERS AND SAFETY CAGES

- A. General:
  - 1. Comply with ANSI A14.3, unless otherwise indicated.
  - 2. Elevator Pit Ladders: Comply with ASME A17.1.
  - 3. Space siderails 16 inches apart, unless otherwise indicated.
- B. Steel Ladder Construction:
  - 1. Flat bar siderails, with 3/4-inch- diameter steel bar rungs fitted in centerline of siderails, plug-welded, and ground smooth on outer rail faces.
- C. Aluminum Ladder Construction:
  - 1. Extruded channel or tube siderails, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick; with extruded tube rungs, not less than 3/4 inch deep and not less than 1/8 inch thick, fitted into centerline of siderails and fastened by welding or with stainless-steel fasteners or brackets and aluminum rivets.
  - 2. Provide rungs with ribbed tread surfaces.
- D. Internal Ladders from Roof or Ceiling Hatches: For ladders greater than eight feet, provide stainless steel or aluminum ladder extension, consisting of a single pole extension 42-inches above top ladder rung, rotating locking mechanism, and two ladder rung clamps.
- E. Fall Prevention Device: When required by OSHA, each ladder shall have a fall prevention device attached. This device shall consist of a sliding locking mechanism and safety belt. This device shall fully comply with OSHA standards.
- F. Safety Cages:
  - 1. Fabricate ladder safety cages to comply with ANSI A14.3.
  - 2. Fabricate from same metal as ladders to which safety cages are attached and assemble by welding or riveting.
  - 3. Exterior Steel Ladders and Safety Cages: Galvanize.

## 2.10 ALTERNATING TREAD STAIR

- A. Construction Requirements:
  - 1. Landings, Treads, and Mounting Base: Stamped and formed from single piece material. Stock shapes, hand forming, or welded remnants shall not be permitted. All stamped parts shall have integrally formed rigidizing bends and shall be spot welded to stringers of like material.
  - 2. Welds: Minimum of 6 welds per tread and 12 welds each on the landing and mounting base. Each weld shall be quality controlled and be capable of withstanding a minimum of 2800 lbs. in shear.
  - 3. Pedestrian Surfaces: Punched through with upset non-skid openings.
  - 4. Riser Spacing: Equally spaced to within 3/16 inch for adjacent risers and to within 3/8 inch for any two non-adjacent risers on a stair.
  - 5. Guards and Handrails: Contoured for body guidance and underarm support and shall be attached to the outside stringers and landings by bolting.
  - 6. Landing Reinforcement: 1/4 inch steel angle notched and punched and factory welded to the landing at the points of a guard or handrail attachment.
  - 7. Rubber Foot Divider: shall Affixed to the central portion of the landing. A rubber bumper strip shall be attached or will be provided for field attaching to the central

stringer.

8. Finish: Hot-dip galvanize per ASTM A 123.

B. Dimensions and Angle:

1. Alternating Tread Stair Angle: 56 or 68 degrees from horizontal as specified in the drawings.
2. Vertical Drop: Change in elevation, as shown in the Drawings, between the upper finished floor surface where the top landing will be attached and the lower finished floor surface where the base of the alternating tread stair will be secured.

C. Available Manufacture:

1. Lapeyre Stair, Inc.; Harahan, LA.

## 2.11 FLOOR/VAULT/SIDEWALK HATCHES

- A. Description: Provide single or double leaf hinged covers, designed for corrosive environment and sized with clear openings as shown on the Drawings.

B. Construction Details:

1. Materials: Cover and Frame: 1/4-inch aluminum minimum.
2. Cover: Diamond-pattern tread plate, either reinforce for AASHTO H-20 wheel loadings for off-street locations or for a 300 psf live load as shown on the Drawings.
3. Frame: Extruded aluminum angle or channel frame with bend down tabs around perimeter. Frame shall be equipped with 1-1/2-inch drain coupling welded under frame for a pipe connection if designated on the Drawings.
4. Gasket: EDPM gasket mechanically attached to frame.
5. Hinges: Heavy stainless steel with 1/4-inch Type 316 stainless steel hinge pins. Hinges shall be attached to cover using tamper proof stainless steel hardware.
6. Latch: Type 316 stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle. Latch release protected by a flush, gasketed, remove screw plug.
7. Lift Assistance: Stainless steel compression spring operators enclosed in telescopic tubes with automatic hold-open device with grip handle release.
8. Finish: Mill finish aluminum with bituminous coating applied to the exterior frame.
9. Hardware: Engineered composite compression spring tubes; stainless steel compression springs; and all other components of door are aluminum or Type 316 stainless steel.

- C. Safety Grate: When designated on the Drawings, provide a fall protection hinged safety grate installed with each leaf cover in accordance with the following requirements:

1. Material: Aluminum grate sized for 300 psf live load.
2. Hinges: Heavy stainless steel with 1/4-inch Type 316 stainless steel hinge pins.
3. Lift Assistance: Automatic hold-open device with grip handle release.
4. Finish: Mill finish aluminum with powder coated safety orange color.

D. Manufacturer:

1. Bilco Company
2. Halliday Products, Inc.

3. ITT Flygt
4. USF Fabrication, Inc.
5. EJCO

#### 2.12 METAL BOLLARDS:

- A. Requirements:
  1. Fabricate from Schedule 40 steel pipe.
  2. Cap bollards with 1/4-inch- thick steel plate if bollard is not concrete filled.
- B. Mounting:
  1. When mounting bollard on concrete slab or pavement, fabricate bollards with 3/8-inch- thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
    - a. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
  2. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- thick steel plate welded to bottom of sleeve, if required.
- C. Coating: Apply bituminous paint to concealed bottoms, sides, and edge of bollards set in concrete.

#### 2.13 PIPE GUARDS

- A. Fabricate from 3/8-inch- thick by 12-inch- wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

#### 2.14 METAL FLOOR PLATE:

- A. Requirements:
  1. Fabricate from plate material indicated on the Drawings and thickness indicated below:
    - a. Thickness: 1/4 inch, unless otherwise indicated on Drawings.
  2. Provide angle supports of the same material as the plate as indicated.
  3. Provide flush bar drop handles for lifting removable sections, one at each end of each section.

#### 2.15 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS.

- A. Cast-Metal Units:
  1. Cast aluminum, with an integral abrasive finish.
    - a. Available Manufacturers:
      - 1) American Safety Tread Co., Inc.
      - 2) Balco Inc.
      - 3) Wooster Products Inc.
      - 4) Approved equal.
  2. Extruded Units: Aluminum, with abrasive filler in an epoxy-resin binder.
    - a. Available Manufacturers:

- 1) American Safety Tread Co., Inc.
  - 2) Balco Inc.
  - 3) Wooster Products Inc.
  - 4) Approved equal.
- b. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
3. Provide anchors for embedding units in concrete, either integral or applied to units.

## 2.16 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.
- B. Steel and Iron Finishes:
1. Hot-dip galvanize items as indicated to comply with ASTM A 123 or ASTM A 153 as applicable.
  2. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with the coating system selected in accordance with SECTION 09 91 00 - PAINTING AND PROTECTIVE COATINGS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.
1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.
  2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
  3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- B. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.
- C. Bollards:
1. Install bollards as shown on the Drawings and the following as applicable:
    - a. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch bolts at each bollard.
    - b. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout.
    - c. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.



2. If bollard does not have a metal cap, fill bollards solidly with concrete, mounding top surface to shed water.
- D. Touch up surfaces and finishes after erection.
1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.
  2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

**END OF SECTION**

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**SECTION 06 61 00**  
**POLYMER CONCRETE WET WELLS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This specification covers polymer concrete wet wells intended for use in sanitary sewers.

**1.2 RELATED SECTIONS**

- A. SECTION 01 45 00 QUALITY CONTROL

**1.3 REFERENCE STANDARDS**

A. American Concrete Institute (ACI)

1. 548.6R-96 – Polymer Concrete-Structural Applications State-of-the-Art Report
2. 350-06 – Code Requirements for Environmental Engineering Concrete Structures & Commentary

B. ASTM International (ASTM)

1. C 267 – (most current) Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes
2. C 443 – (most current) Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
3. C 478 – (most current) Standard Specification for Precast Reinforced Concrete Manhole Sections.
4. C 579 – (most current) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes
5. C 580 – (most current) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
6. C 857 – (most current) Standard Practice for Minimum Structural Design Loading for Underground Utility Structures.
7. C 923 – (most current) Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe.
8. C 990 – (most current) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants
9. C 497 – (most current) Test Methods for Concrete Pipe, Manhole Sections, or Tile.
10. D 648 – (most current) Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position.
11. D 2584 – (most current) Test Method for Ignition Loss of Cured Reinforced Resins.
12. D 6783 – (most current) Standard Specification for Polymer Concrete Pipe.

**1.4 SUBMITTALS**

- A. Conform to bid document requirements.
- B. Submit manufacturer's data and details of following items for approval:
1. Shop drawings of Wet Wells sections, base units and construction details, jointing

- methods, materials, and dimensions.
2. Summary of criteria used in Wet Well design including, as minimum, material properties, loading criteria, and dimensions assumed. Include certification from manufacturer that polymer concrete Wet Well design meets or exceeds the load and strength requirements of ASTM C 478 and ASTM C 857.
  3. Frames, grates, rings, and covers.
  4. Materials to be used in fabricating pipe drop connections.
  5. Materials to be used for pipe connections.
  6. Materials to be used for stubs and stub plugs, if required.
  7. Proof of independent chemical resistance testing conducted in accordance with ASTM C 267.
  8. References of 10 previous polymer concrete projects including scope in the last 5 years performed with both owner and contractor for reference and review by owner.
- C. Delegated-Design Submittal: Wet well design, including all polymer concrete components of base, riser sections, walls, and tops, shall be designed and sealed by a qualified Oklahoma registered Professional Engineer responsible for their preparation, including analysis data.

## PART 2 - PRODUCTS

### 2.1 POLYMER CONCRETE WET WELLS

- A. Provide polymer concrete sections, monolithic base sections and related components referencing to ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product.
- B. Provide base riser section with monolithic floors, unless shown otherwise.
- C. Provide riser sections joined with bell and spigot / ship-lap design seamed with butyl mastic and/or rubber gaskets (ASTM C 443) so that on assembly, Wet Well base, riser and top section make a continuous and uniform structure.
- D. Construct riser sections for polymer concrete Wet Wells from standard polymer concrete sections of the diameter indicated on drawings. Use various lengths of polymer concrete sections in combination to provide correct height with the fewest joints.
- E. Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer.
- F. Provide tops to support AASHTO HS-20 loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings.

### 2.2 DESIGN CRITERIA

- A. Polymer Concrete risers, cones, flat lids, and grade rings shall be designed by manufacturer to meet ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.
  1. AASHTO HS-20 design or as required loading applied to wet well cover and transition and base slabs.
  2. Polymer Wet Wells will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06.

3. Unit soil weight of 120 pcf located above portions of wet well, including base slab projections.
4. Internal liquid pressure based on unit weight of 63 pcf.
5. Dead load of Wet well sections fully supported by polymer concrete wet well base.

## 2.3 DESIGN

- A. Polymer Concrete risers, cones, flat lids, grade rings and base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete wet well design as follows:
  1. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment.
  2. Reinforcement shall be in accordance with ASTM C478.
  3. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness.
  4. Thermosetting Resin - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete structures will be exposed.
  5. Each polymer concrete component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defects shall not be cause for rejection. The nominal internal diameter of Wet Well components shall not vary more than 2%. Variations in height of two opposite sides of risers and cones shall not be more the 5/8 inch. The under run in height of a riser or cone shall not be more than ¼ in/ft of height with a maximum of ½ inch in any one section.
  6. Marking and Identification - Each Wet Well section shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date.
  7. Wet well joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, wet well base, riser and top section make a continuous and uniform. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity.
  8. Minimum clearance between wall penetrations and joints shall be per manufacturer's design.
  9. Grading of wet well base:
    - a. If using invert channels, channels shall be constructed to provide smooth flow transition with minimal disruption of flow at pipe-wet well connections. Invert slope through Wet Well is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all-polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material.
    - b. If grouting, base of wet well shall be grouted at grades indicated in plans using

grout compliant with Structural General Notes as shown on the plans.

10. Provide resilient connectors conforming to requirements of ASTM C 923. All connectors are to be watertight. Install approved resilient connectors at each pipe entering and exiting Wet Well in accordance with manufacturer's instructions.

#### 2.4 QUALITY CONTROL

- A. All fabrication will take place in an all-polymer concrete fabrication facility. At no time will the polymer concrete fabrication facility share the facility with a cementitious precast product production facility. Fabricator is also to provide references of 10 previous projects in the last 5 years performed with both owner and contractor for reference and the scope and review by owner. Polymer concrete shall be cast in a polymer only facility and shall not be manufactured in a cementitious concrete facility.

#### 2.5 GROUTING

- A. All materials needed for grouting and patching will be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer. Refer to Structural General Notes on Drawing S-100 for grout information.

#### 2.6 TESTING

- A. Polymer Concrete Wetwells shall be leakage tested in accordance with Division 01 Section 01 45 00.

#### 2.7 MANUFACTURER

- A. The manufacturer shall be one of the following:
  1. Armorock LLC, 207 Heritage Court, Sulphur Springs, TX 75482, 702-824-9702
  2. U.S. Composite Pipe, Inc., 800 CR 209, Alvarado, TX 76009, 817-783-3444
  3. Or approved equal.

**END OF SECTION**

**SECTION 09 91 00**  
**PAINTING AND PROTECTIVE COATINGS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the surface preparation and application of high-performance coating systems on the following substrates:
  - 1. Exterior substrates:
    - a. Concrete, vertical, and horizontal surfaces.
    - b. Clay masonry.
    - c. Concrete masonry units (CMU).
    - d. Steel.
    - e. Galvanized metal.
    - f. Aluminum (not anodized or otherwise coated).
    - g. Wood.
    - h. Plastic trim fabrications.
    - i. Exterior Portland cement (stucco).
    - j. Exterior gypsum board.
    - k. PVC pipe and fiberglass tanks.
  - 2. Interior Surfaces:
    - a. Concrete.
    - b. Clay masonry.
    - c. Concrete masonry units (CMU).
    - d. Steel.
    - e. Galvanized metal.
    - f. Aluminum (not anodized or otherwise coated).
    - g. Wood.
    - h. Gypsum board.
    - i. Plaster.
    - j. Spray-textured ceilings.
    - k. Cotton or canvas insulation covering.
- B. Related Sections:
  - 1. Applicable equipment Sections for manufacturer's special coatings of equipment.
- C. Related Documents:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 REFERENCES AND DEFINITIONS**

- A. References:
  - 1. ASTM International (ASTM)
    - a. D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related

Products.

- b. D2016 - Test Method for Moisture Content of Wood.
  2. The Society for Protective Coatings (SSPC)
    - a. SSPC Painting Manual, "Good Painting Practice"
    - b. SSPC Painting Manual, "Systems and Specifications"
    - c. SSPC-SP1 Solvent Cleaning
    - d. SSPC-SP3 Power Tool Cleaning
    - e. SSPC-SP5 White Metal Blasting
    - f. SSPC-SP6 Commercial Blast Cleaning
    - g. SSPC-SP7 Brush-Off Blast Cleaning
    - h. SSPC-SP10 Near-White Blast Cleaning
    - i. SSPC-SP12 Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating
    - j. SSPC-SP13 Surface Preparation of Concrete
    - k. SSPC-SP14 Industrial Blast Cleaning
    - l. SSPC-VIS 1 89 Visual Standard for Abrasive Blast Cleaned Steel
  3. NACE International (National Association of Corrosion Engineers International)
    - a. RP0287-95 "Field Measurements of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using Replica Tape"
    - b. RP0188-99 "Discontinuity (Holiday) Testing of Protective Coatings"
    - c. TM-01-70 "Visual Comparator for Surfaces of New Steel Airblast Cleaned with Sand Abrasive"
    - d. TM-01-70 "Visual Comparator for Surfaces of New Steel Airblast Cleaned with Slag Abrasive"
    - e. RP0178-95 "Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service"
    - f. RPO 892-92 "Linings Over Concrete for Immersion Service"
    - g. RPO 591-96 "Coatings for Concrete Surfaces in Non-Immersion"
    - h. 6G186 "Surface Preparation of Contaminated Steel Surfaces"
    - i. 6G191 "Surface Preparation of Contaminated Concrete"
    - j. RPO 178 "Weld preparation Visual Comparator"
  4. National Science Foundations (NSF)
- B. Definitions:
1. Conform to ASTM D16 for interpretation of terms used in this Section.
  2. Exposed Surfaces: Used to define painting locations and requirements it shall include all visible interior or exterior surfaces, top of walls, ceilings, and inside surfaces to 1'-0" below grade or the weir level or to floor level, whichever applies.

### 1.3 SUBMITTALS

- A. Product Data: Submit product data, warranty, certificates, and application instructions for each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.



- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches square.
  2. Step coats on Samples to show each coat required for system.
  3. Label each coat of each Sample.
  4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
1. Show where each coating is to be used on the Project, with cross reference to this Section paragraphs and Painting Schedule.
  2. Product date and information submitted shall demonstrate compliance with this Section.
  3. Provide the surface preparation required or recommended by coating manufacturer for each type of coating application if different from that specified in this Section.
- E. Provide ENGINEER with certification from coating supplier that sufficient paint has been purchased to provide required quantity of coatings for Project.
1. Certificate shall list the quantities and types of paint purchased.
- F. Provide ENGINEER with certification from the blast cleaning supplier that sufficient materials have been purchased to provide for the surface preparation specified for Project.
1. Certificate shall list the quantities and gradation purchased.
- G. Manufacturer's Instructions:
1. Provide manufacturer's instructions for the application of the coating system for the purpose intended by these specifications. The instructions shall provide the limitations, precautions, and requirements that may adversely affect the coating system; that may cause unsatisfactorily results after the application; or that may prevent the coating system from serving the purpose for which it was intended, which is to provide coverage and protection from corrosion, shall be clearly stated.
  2. The instructions shall include, but not limited to:
    - a. Surface preparation.
    - b. Methods of Application.
    - c. Number of coats.
    - d. Thickness of each coat.
    - e. Total Thickness.
    - f. Drying time of each coat, including primer.
    - g. Drying time of final coat before placement in service.
    - h. Time allowed between coats.
    - i. Primers required to be used.
    - j. Primers not permitted.
    - k. Use of a primer.
    - l. Compatible topcoats.
    - m. Thinner and use of thinner.
    - n. Weather limitations during and after application (temperature, humidity, wind velocity).

- o. Protection from sun.
  - p. Physical properties of paint, including percent solids content by volume, ingredient analysis, and weight per unit surface per dry mil thickness.
  - q. Cathodic disbonding limitations, if any.
  - r. Equipment settings (air cap, fluid tip, equipment pressure settings, etc.)
- H. Field quality-control reports: Provide temperature and humidity readings, testing for coating dry mil thickness and bonding, surface preparation, and related coating testing.
- I. Pre-installation Conference: Provide minutes of the pre-installation conference.

#### 1.4 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality coating products with 10 years' experience.
- B. Applicator: Company specializing in industrial painting and finishing with five (5) years' documented experience, approved by product manufacturer.
- C. CONTRACTOR shall apply coatings systems from only one manufacturer for each type of application.
- D. CONTRACTOR shall coordinate materials to be painted, shop primers, field primers, and finish coating systems to ensure compatibility for all materials and coatings in this project.
- E. All coatings in contact with potable water and water being treated for use as potable water shall conform to ANSI/NSF Standard 61 and shall be certified by an organization accredited by ANSI. All process, service water, potable, and chemical piping, fittings, tanks, valves, equipment, and structures in contact with the water being treated are included in this requirement.
- F. Coating system manufacturer shall review actual job conditions prior to purchase of any materials. Manufacturer shall submit to ENGINEER a statement listing any exceptions to the specifications regarding preparation requirements or coating applicability.

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame/fuel/smoke rating requirements for finishes.
- B. Preinstallation Conference: Conduct conference at Project site.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and protect products in accordance with manufacturer's instructions.
- B. Deliver products to site in the original, sealed, labeled, and unopened containers; inspect to verify acceptance. Damaged containers will not be accepted.
- C. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
- D. Store paint materials in well ventilated areas with ambient temperatures continuously maintained at not less than 45°F (7 °C) and not more than 90°F (32 °C).
- E. Take precautionary measures to prevent fire hazards and spontaneous combustion. Remove oily rags, waste, or other fire hazards from facilities each night. Place cloths and cotton

waste, which might constitute a fire hazard, in metal containers or destroy at the end of each work day.

## 1.7 PROJECT CONDITIONS

- A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 °F (7°C) for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- B. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95°F (10 and 35°C).
- C. Do not apply coatings in;
  - 1. snow, rain, mist or fog;
  - 2. or when relative humidity meets or exceeds 85 percent;
  - 3. or at temperatures less 5°F (3°C) above the dew point;
  - 4. or when it is predicted the air temperature will drop below 45°F (7°C) or less than 5°F (3°C) above the dew point is forecast within 8 hours after application of coating unless it is enclosed and heated;
  - 5. or to damp or wet surfaces.
- D. Minimum Application Temperatures for Latex Paints: 45°F (7°C) for interiors; 50°F (10°C) for exterior, unless required otherwise by manufacturer's instructions.
- E. Minimum Application Temperature for Varnish and Finishes: 65°F (18°C) for interior or exterior, unless required otherwise by manufacturer's instructions.
- F. Comply with all manufacturer's instructions for coating application and environmental conditions, which may be more stringent than the minimum requirements listed in this specification.
- G. Provide lighting level of 80-foot candles measured mid-height at substrate surface.
- H. CONTRACTOR shall be fully responsible for personnel safety during painting operations.
  - 1. Display caution signs in necessary areas advising of spray painting and warning against open flames.
  - 2. Provide barriers or shelters on windy days to protect equipment and facilities.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Furnish an additional 5 percent, but not less than 1 gallon of each material and color applied.
  - 2. The material shall be delivered in unopened labeled containers as delivered from the manufacturer. If the manufacturer does not deliver in gallon containers, and in the case of special colors, the new gallon containers, properly closed with typed labels indicating brand, type, color, location used, etc.
  - 3. Where multiple component materials are used, provide an unopened kit of the necessary materials in the manufacturer's smallest standard packaging size. Provide three (3) copies of the manufacturer's instructions describing the materials and directions for their use.

4. Provide a typed inventory list of the extra materials furnished at time of delivery.

## 1.9 SPECIAL WARRANTY

- A. Warranty inspection of the coating systems shall be conducted during the eleventh month following completion and acceptance of all coating system work. The personnel or their representatives present at the pre-installation conference are requested to attend. All defective coating systems shall be repaired in accordance with this Section and to the satisfaction of the ENGINEER and OWNER.

## PART 2 - PRODUCTS

### 2.1 PAINT, GENERAL

- A. Material Compatibility:
  1. Provide materials for use within each paint system that are compatible with one another, and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
  1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
  2. Restricted Components: Paints and coatings shall not contain any of the following:
    - a. Acrolein.
    - b. Acrylonitrile.
    - c. Antimony.
    - d. Benzene.
    - e. Butyl benzyl phthalate.
    - f. Cadmium.
    - g. Di (2-ethylhexyl) phthalate.
    - h. Di-n-butyl phthalate.
    - i. Di-n-octyl phthalate.
    - j. 1,2-dichlorobenzene.
    - k. Diethyl phthalate.
    - l. Dimethyl phthalate.
    - m. Ethylbenzene.
    - n. Formaldehyde.
    - o. Hexavalent chromium.
    - p. Isophorone.
    - q. Lead.
    - r. Mercury.

- s. Methyl ethyl ketone.
- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

## 2.2 COLOR SCHEDULE

### A. Color Selection:

- 1. Colors: As selected by OWNER from manufacturer's full range of colors.
- 2. Colors selected may or may not be the manufacturer's standard color.
- 3. Submit color charts to OWNER at least 60-days prior to coating application to allow time for color selection.
- 4. Different colors will be selected for concrete structures; building columns, framing, walls, window and door frames, and other areas; various items of equipment; piping and conduit; safety colors will be used for fire equipment locations, protective covers for rotating or moving equipment, walkways, and other related items; architectural treatment, both interior and exterior of buildings; and for all other items of Work.
- 5. Colors for equipment shall be selected by OWNER during submittal process.

### B. Colors selection for piping systems and identification of piping systems shall be in accordance with Section 10 90 00 "Identification, Stenciling, and Tagging".

## 2.3 MANUFACTURERS

### A. Acceptable Manufacturers: Provide coating products from one of the manufacturers listed, if not listed under each Painting System Application:

- 1. Carboline Protective Coatings and Linings, St. Louis, MO.
- 2. PPG Protective and Marine Coatings (formerly Ameron Coatings).
- 3. Tnemec Company, Inc., Kansas City, MO.
- 4. Valspar.

## 2.4 MATERIALS

- A. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
- B. CONTRACTOR shall have complete responsibility for ensuring that each coating applied is compatible with its substitute and/or its intended finish coat, and that the completed coating system is suitable for its intended service.
- C. Accessory Materials: Thinning of paint and all accessory type materials used shall be strictly in accordance with the manufacturer's recommendations covering material types, solvents, mix ratios, and methods.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Masonry (Clay and CMU): 12 percent.
  - 3. Wood: 15 percent.
  - 4. Gypsum Board: 12 percent.
  - 5. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

### 3.2 PREPARATION

- A. Surface of substrates to be coated shall be prepared in accordance with the SSPC specification as listed in Part 3.6 and as described in the paragraphs below.
- B. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- C. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
  - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- D. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove unknown primers or coatings systems and incompatible primers of shop painted work and reprime substrate with compatible primers as required to produce paint systems indicated.
    - a. When removal is not feasible and with approval of ENGINEER, CONTRACTOR may apply a barrier coat in accordance with coating manufacturer's instructions prior to application of the designated coating system.
  - 2. When sandblasting, use a source of compressed air, which is free of detrimental water and oil and capable of delivering the required volume and pressure.
  - 3. Subject to review by ENGINEER, any substrate in which SPPC-SP6 or SPPC-SP10 sandblasting cannot be accomplished shall be cleaned in accordance with SPPC-SP3 removing loose mill scale, rust, paint, and other foreign matter.
- E. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk.

Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

1. Allow new concrete to cure for 28-days.
- F. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceeds that permitted in manufacturer's written instructions.
- G. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- H. Steel Substrates: Remove rust and loose mill scale, if work has not been shop primed with coating system compatible primer. Clean using methods recommended in writing by paint manufacturer.
- I. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- J. Aluminum Substrates: Remove surface oxidation.
- K. Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  2. Sand surfaces that will be exposed to view, and dust off.
  3. Prime edges, ends, faces, undersides, and backsides of wood.
  4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- L. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
- M. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
- N. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
- O. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

### 3.3 PROTECTION

- A. Protect elements surrounding the work of this Section from damage or disfiguration.
- B. Repair damage to other surfaces caused by work of this Section.
- C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site and dispose of all excess materials and empty containers in full accordance with all applicable state, federal, and local laws.

### 3.4 APPLICATION

- A. Minimum Dry Film Thickness (MDF). Where applicable, the Coating Schedule includes the minimum dry film thickness required for the various coating systems specified. The film thickness is measured in mils.

- B. Apply products in accordance with manufacturer's instructions regarding drying time between coats, technique of application, ventilation, paint thinning, and safety precautions.
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- C. Allow applied coat to dry for the time specified by the coating manufacturer before next coat is applied. Do not apply finishes to surfaces that are not dry to touch.
- D. Apply each coat to uniform finish; free from runs, drips, ridges, waves, laps, brush marks and variations in color, texture and finish.
- E. Where multiple coats are specified; apply each coat in a different color, which compliments the following coat and is different than the proceeding coat. Each coat must be free of shadows and uniform in appearance.
- F. Sand lightly between coats to achieve required finish
- G. Double-lap all welds. Apply prime coat by brush to all weld areas; then apply prime coat to entire surface, including weld areas.
- H. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- I. Prime back surfaces of interior and exterior woodwork with primer paint.
- J. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
- K. Paint all items throughout the project except for surfaces listed below unless shown otherwise in the plans or specifications:
  - 1. Concrete walkways, pavement, sidewalks, and stair treads.
  - 2. Interior fiberglass items unless specified otherwise. Exterior fiberglass shall be painted.
  - 3. Metal surfaces of anodized aluminum, stainless steel, or chromium plate.
  - 4. Operating parts, unless otherwise specified.
  - 5. Existing structures or equipment, unless otherwise specified.
  - 6. Equipment, valve, and other items nameplates or serial numbers.
  - 7. Valve operator stems.
- L. Repair any damage or overspray to paint on existing structures caused by construction work. Match existing colors with touch-up paint.
- M. New concrete and rubbed finish and mortar joints shall age a minimum of 30 days before application of coatings.
- N. Concrete surfaces to be painted shall be coated prior to installation of equipment, piping, conduit and supports and touched up following installation of these items. Components, which cannot be adequately painted due to space limitations following installation, shall be coated prior to installation, and touched up after installation as well.



- O. Where inspection shows that the specified thickness is not developed, apply additional coats in accordance with manufacturer's instructions and cure schedule requirements to produce the required dry film thickness.

### 3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Section 10 90 00 "Identification, Stenciling, and Tagging" and Section 26 05 53 "Identification for Electrical Systems" for requirements for color-coding and identification banding of ductwork, piping, conduit, and identification systems.
- B. Paint shop primed equipment. Touchup paint equipment furnished with factory coatings with manufacturer's correct color.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports. For insulated pipe, provide shop and field primer coats on pipe and surface preparation and final coat on insulation jacket.
- E. Replace identification markings on mechanical or electrical equipment when painted accidentally.
- F. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- G. Paint exposed conduit and electrical equipment occurring in finished areas.
- H. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
- I. Color code equipment, piping, conduit, and exposed ductwork in accordance with requirements indicated. Color band and identify with flow arrows and names.
- J. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
- K. Coating systems applied at the factory shall be protected against damaged during transit, delivery, storage, and erection. Damaged areas shall be refinished as the original so that end of the Project the finish will be in perfect shape.
  - 1. The following items shall receive factory applied coatings:
    - a. Electrical panels, motor control centers, transformers, and related items.
    - b. Light fixtures.
    - c. Pressure gauges.
    - d. Instrumentation.

### 3.6 SURFACE PREPARATION AND COATING SCHEDULE

- A. Cast-in Place Concrete Walls and Ceilings, Precast Concrete Surfaces, Equipment Bases, Pipe Supports, and Similar Surfaces, all with "smooth rubbed finish," Interior, Non-submerged, where painting is specified:
  - 1. Surface preparation: SSPC-SP13 Surface Preparation of Concrete.
  - 2. Product and Manufacturer: Provide one of the following:

- a. Tnemec:
    - 1) Primer: 66 Hi-Build Epoxoline - 1 coat, 5.0 MDF.
    - 2) Finish: 66 Hi-Build Epoxoline - 1 coat, 4.0 MDF.
  - b. Carboline:
    - 1) Primer: Carboline 890 - 1 coat, 5.0 MDF.
    - 2) Finish: Carboline 890 - 1 coat, 4.0 MDF.
  - c. PPG:
    - 1) Primer: Amercoat 385 - 1 coat, 5.0 MDF.
    - 2) Finish: Amercoat 385 - 1 coat, 4.0 MDF.
  - d. Valspar:
    - 1) Primer: 89 Series - 1 coat - 5.0 MDF.
    - 2) Finish: 89 Series - 1 coat - 4.0 MDF.
- B. New and Existing Concrete, Exposed, Exterior, Not Submerged or Not Intermittently Submerged where painting is required.
- 1. Surface Preparation: SSPC-SP13 Surface Preparation of Concrete.
  - 2. Product and Manufacturer:
    - a. Tnemec:
      - 1) Finish: Series 52 Tneme-Crete, 1 coat, 9.0 MDF.
    - b. Carboline:
      - 1) Primer: 954HB, 1 coat, 120 sf. ft/gallon.
      - 2) Finish: 954HB, 1 coat, 9.0 MDF.
    - c. PPG:
      - 1) Primer: Amerlock 400, 1 coat, 9.0 MDF.
      - 2) Finish: Amercoat 450HS, 1 coat, 2.0 MDF.
    - d. Valspar:
      - 1) Finish: 46 Series V-Fill, 1 coat, 9.0 MDF.
- C. Concrete Block Walls and Cast-In-Place Concrete not conforming to smooth rubbed finish, Interior, where painting is specified:
- 1. Surface Preparation: SSPC-SP13 Surface Preparation of Concrete.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 54-660 Epoxy Polyamide Masonry Filler - 1 coat, 100 square feet per gallon for lightweight and haydite block.
      - 2) Finish: 66 Hi-Build Epoxoline - 2 coats, 5.0 MDF per coat.
    - b. Carboline:
      - 1) Primer: Carboguard 954HB - 1 coat, 85-125 sf/gallon.
      - 2) Finish: Carboline 890 - 2 coats, 5.0 MDF per coat.
    - c. PPG:
      - 1) Primer: Amerlock 400BF, Epoxy Block Filler - 1 coat, 100 sf/gallon.
      - 2) Finish: Amercoat 385 - 2 coats, 5.0 MDF per coat.

- d. Valspar:
  - 1) Primer: 46-x-29 1 coat, 100 square feet per gallon.
  - 2) Finish: 89 Series - 2 coats, 5.0 MDF per coat.
- D. Concrete Floors and Walks, Interior, where painting is required:
  - 1. Surface preparation: Acid etch.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: Series 203 Enviroprime LV - 1 coat, 3.0 MDF.
      - 2) Finish: Series 280 Tneme-Glaze - 1 coat, 4.0 MDF. Add 5 pounds of 50 mesh dry wash silica sand to topcoat to provide a non-skid surface in walkway areas.
    - b. Carboline:
      - 1) Primer: Carboline 1340 clear - 1 coat, 3.0 MDF.
      - 2) Finish: Carboline 890 - 1 coat, 4.0 MDF with clean, dry sand broadcast into the film and back rolled to encapsulate.
    - c. PPG:
      - 1) Primer: Nu-Klad 105A, - 1 coat, 250-400 square feet per gallon theoretical.
      - 2) Finish: Amershield - 1 coat, 5.0 MDF. Add 5 pounds 50 mesh dry wash silica sand to topcoat to provide a non-slip surface for walkway areas.
    - d. Valspar:
      - 1) Primer: 89 Series 1 coat, 2.0 MDF.
      - 2) Finish: 89 Series w/sand 2 coats, 2.0 MDF per coat.
- E. Submerged or intermittently submerged Concrete, Interior and Exterior, except for potable water service, and where special protective coatings are required:
  - 1. Surface Preparation: Remove all surface contaminants such as old coatings, loose concrete, chemical salts, dust, etc., by brush-blast cleaning as required; remove all grease, oils, and grime by washing with an emulsifying alkaline base cleaner; follow with through rinsing in accordance with manufacturer's instructions.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Finish: 46-H-413 Tneme-Tar, 1 coat, 16 MDF per coat.
    - b. Carboline:
      - 1) Finish: Carbomastic 300, 2 coats, 8-10 MDF per coat.
    - c. PPG:
      - 1) Finish: Amercoat 78HV Coal Tar Epoxy, 2 coats, 8-10 MDF per coat.
    - d. Valspar:
      - 1) Finish: 64-J-5 Coal Tar Epoxy, 2 coats, 8-10 MDF per coat.
- F. Masonry, Exterior, where painting is required:
  - 1. Surface Preparation: SSPC-SP7 Brush off Blast Cleaning.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:

- 1) Finish: Series 52 Tneme-Crete, 2 coats, 8.0 MDF per coat.
  - b. Carboline:
    - 1) Primer: 954HB, 1 coat, 120 sf/gallon.
    - 2) Finish: 954HB, 2 coats, 35-45 sf/gallon depending on texture.
  - c. PPG:
    - 1) Primer: Amerlock 400 primer, 1 coat, 8 MDF.
    - 2) Finish: Amercoat 450HS, 2 coats, 2.0–3.0 MDF per coat.
  - d. Valspar:
    - 1) 46 Series V-Fill & Finish, 2 coats, 8.0 MDF per coat.
- G. Ferrous Steels including Structural Metal Bar Joists, Miscellaneous Metals and Piping, including piping to be insulated, Interior:
- 1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Shop Primer: Series 37H Chem-Prime, 1 coat, 2.0 MDF.
      - 2) Shop Primer for Bar Joists: Series 37H Chem-Prime, 1 coat, 2.0 MDF.
      - 3) Field primer or field touch-up: Series 37H Chem-Prime, 1 coat, 2.0 MDF.
      - 4) Finish: Series 66 Epoxoline, 1 coat, 4.0 MDF.
    - b. Carboline:
      - 1) Shop primer for bar joists, field primer or touch-up: Rustbond Penetrating Sealer, 1 coat, 2.0 MDF.
      - 2) Finish: Carboline 890, 1 coat, 4.0 MDF.
    - c. PPG:
      - 1) Shop primer: Amercoat 68HS, 1 coat, 3.0 MDF.
      - 2) Shop primer for Bar Joists, Field, or Field touch-up is the same as the shop primer.
      - 3) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
    - d. Valspar:
      - 1) Primer: 13-R-28 Phenolic-Alkyd Primer, 1 coat, 2.0 MDF.
      - 2) Finish: 89 Series - 1 coat, 4.0 MDF.
- H. Ferrous Metals Encased in Concrete, Plaster, Fireproofing and Similar Materials:
- 1. Surface preparation: SSPC SP6, Commercial Blast Cleaning.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Shop Primer and Field Touch-up: Series 46H-413 red, 1 coat, 2.0 MDF.
    - b. Carboline:
      - 1) Shop Primer and Field Touch-up: Carboline GH818 Red, 1 coat, 2.0 MDF.
    - c. PPG:
      - 1) Shop Primer and Field Touch-up: Amercoat 5105, 1 coat, 2.0 MDF.
    - d. Valspar:

- 1) Shop Primer and Field Touch-up: 13-4-78 Primer, 1 coat, 2.0 MDF.
  3. Verify the compatibility of primer with fireproofing manufacturer.
- I. Ferrous Metals, Interior and Exterior, Submerged or Intermittently Submerged, except in potable water:
1. Surface Preparation: SSPC-SP10, Near-White Blast.
  2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Shop Primer: Series 66 Hi-Build, 1 coat, 4.0 MDF.
      - 2) Finish: 46-H-413 Tneme-Tar, 1 coat, 16.0 MDF per coat,
    - b. Carboline:
      - 1) Shop Primer: Carboline 893, 1 coat, 4.0 MDF.
      - 2) Finish: Bitumastic 300M, 2 coats, 8.0 MDF per coat.
    - c. PPG:
      - 1) Shop Primer: Amercoat 370 Polyamide Epoxy Primer, 1 coat, 4.0 MDF.
      - 2) Finish: Amercoat 78HB Coal Tar Epoxy, applied in 1 or 2 coats cross hatched to achieve 16 MDF for the Coal Tar Epoxy.
    - d. Valspar:
      - 1) Shop Primer: 89 Series Epoxy or 64-R-3, 1 coat, 4.0 MDF.
      - 2) Finish: 64-J-5 Coal Tar Epoxy, 2 coats, 8.0 MDF per coat.
- J. All surfaces in contact with potable water:
1. Surface Preparation:
    - a. Interior Ferrous Metals, submerged or intermittently submerged:
      - 1) SSPC-SP10, Near White Blast.
    - b. Interior Ferrous Metals dry:
      - 1) SSPC-SP6, Commercial Blast.
    - c. Concrete:
      - 1) Brush Blast.
  2. Products and Manufacturer:
    - a. Tnemec:
      - 1) Primer: Series 20-1255 Pota Pox Primer, 1 coat, 5.0 MDF.
      - 2) Finish: Series 20-2000 Pota Pox Finish, 1 coat, 5.0 MDF.
    - b. Or approved equivalent by named manufacturers.
- K. Ferrous Metals, Exterior:
1. Shop Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
  2. Field Surface Preparation: Sandblasting of field welds and other imperfections. ENGINEER may require all areas to be blasted at his discretion, in accordance with SSPC-SP6, commercial blast.
  3. Products and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Shop Primer: Series 66 Epoxoline, 1 coat, 2.0 MDF.

- 2) Field Primer: Series 66 Epoxoline, 1 coat, 2.0 MDF.
  - 3) Finish: Series 74 Endura-Shield, 1 coat, 3.0 MDF.
  - b. Carboline:
    - 1) Shop Primer: Carboline 893, 1 coat, 3.0 MDF.
    - 2) Field Primer: Carboline 893, 1 coat, 3.0 MDF.
    - 3) Finish: Carboline 134, 2 coats, 1.5 MDF per coat.
  - c. PPG:
    - 1) Shop/Field primer: Amercoat 385 Polyamide Epoxy 1 coat, 4.0 MDF.
    - 2) Finish: Amercoat 450HS High Solids Aliphatic Polyurethane, 2 coats, 1.5 MDF per coat.
  - d. Valspar:
    - 1) 89 Series, 1 coat, 2.5 MDF.
    - 2) 89 Series, 1 coat, 2.5 MDF.
    - 3) V40 Series Urethane, 2 coats, 1.5 MDF per coat.
- L. Galvanized Metal and Non-Ferrous Metal, Interior:
- 1. Surface Preparation: Solvent Cleaning, SPPC-SP1.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Finish: 66 Epoxoline, 1 coat, 5.0 MDF.
    - b. Carboline:
      - 1) Finish: Carboline 890, 1 coat, 5.0 MDF.
    - c. PPG:
      - 1) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 5.0 MDF.
    - d. Valspar:
      - 1) Finish: 89 Series, 1 coat, 5.0 MDF.
- M. Galvanized Metal and Non-Ferrous Metal, Exterior, where painting is required:
- 1. Surface Preparation: Solvent Cleaning, SSPC-SP1.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 66 Epoxoline, 1 coat, 4.0 MDF.
      - 2) Finish: Series 71 Endura-Shield, 1 coat, 1.5 MDF.
    - b. Carboline:
      - 1) Primer: Carboline 893, 1 coat, 4.0 MDF.
      - 2) Finish: Carboline 134, 1 coat, 1.5 MDF.
    - c. PPG:
      - 1) Primer: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
      - 2) Finish: Amercoat 450HS High Solids Aliphatic Polyurethane, 1 coat, 1.5 MDF.
    - d. Valspar:
      - 1) Primer: 89 Series, 1 coat, 4.0 MDF.

- 2) Finish: V40 Series, 1 coat, 1.5 MDF.
- N. Galvanized Ferrous Metal, Interior, Non-Ferrous Metal Submerged or Intermittently Submerged:
1. Surface Preparation: Solvent Cleaning SSPC-SP1 or hand tool clean, SSPC-S82, to remove insoluble contaminants.
  2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 66-1211 Epoxoline primer, 1 coat, 4.0 MDF.
      - 2) Finish: Series 66 Hi-Build Epoxoline, 1 coat, 4.0 MDF.
    - b. Carboline:
      - 1) Primer: Carboline 893, 1 coat, 4.0 MDF.
      - 2) Finish: Carboline 890, 1 coat, 4.0 MDF.
    - c. PPG:
      - 1) Primer: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
      - 2) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
    - d. Valspar:
      - 1) Primer: 89 Series, 1 coat, 4.0 MDF.
      - 2) Finish: 89 Series, 1 coat, 4.0 MDF.
  3. Brush all weld seams, rivets, bolt and nuts, etc. with 50 percent thinned solution prior to first full coat.
- O. All Metal Surfaces Exposed to Temperatures Over 250oF.
1. Surface Preparation: SSPC-SP10 Near-White Blast.
  2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Finish: 39-1261 Silicone Aluminum, 2 coats, 1.0 MDF.
    - b. Carboline:
      - 1) Finish: Carboline 4700 Aluminum, - 2 coats, 1.0 MDF per coat.
    - c. PPG:
      - 1) Finish: Amercoat 878 Silicone Aluminum, 2 coats, 1.0 MDF per coat.
    - d. Valspar:
      - 1) 37-A-10 Heat Resisting Aluminum, 2 coats, 1.0 MDF per coat.
- P. All Aluminum in Contact with Dissimilar Materials:
1. Surface Preparation: Remove all foreign matter.
  2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Series 66 Hi-Build Epoxoline, 2 coats, 4.0 MDF per coat
    - b. Carboline:
      - 1) Carboline 893, 2 coats, 4.0 MDF per coat.
    - c. PPG:
      - 1) Amercoat 385 Polyamide Epoxy, 2 coats, 4.0 MDF per coat.

- d. Valspar:
    - 1) 89 Series, 2 coats, 4.0 MDF per coat.
  - e. Sigma:
    - 1) #7456 Hi Build High Solids Epoxy, 2 coats, 4 MDF per coat.
- Q. Mill-Coated Steel Pipe (Exterior):
- 1. Surface Preparation: SSPC-SP10 Near-White Blast Cleaning.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 66-1211 Epoxoline Primer, 1 coat, 4.0 MDF.
      - 2) Finish: Series 66 Hi-Build Epoxoline, 1 coat, 4.0 MDF.
      - 3) Exterior Finish (UV Exposure): Series 74 Endura-Shield, 1 coat, 4.0 MDF.
    - b. Carboline:
      - 1) Primer: Carboline 893, 1 coat, 4.0 MDF.
      - 2) Finish: Carboline 890, 1 coat, 4.0 MDF.
      - 3) Exterior Finish: Similar to TNEMEC.
    - c. PPG:
      - 1) Primer: Amercoat 385 Polyamide Epoxy, 1 coat, 4 MDF.
      - 2) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
      - 3) Exterior Finish: Similar to TNEMEC.
    - d. Valspar:
      - 1) Primer: 89 Series, 1 coat, 4.0 MDF.
      - 2) Finish: 89 Series, 1 coat, 4.0 MDF.
      - 3) Exterior Finish: Similar to TNEMEC.
- R. Plaster and Dry Wall Interior:
- 1. Surface Preparation: Sand and seal.
  - 2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 51-792 PVA Sealer, 1 coat, 1.0 MDF.
      - 2) Finish: Series 66 Hi-Build Epoxoline, 2 coats, 4.0 MDF per coat.
    - b. Carboline:
      - 1) Primer: Carboline 120, 1 coat, 1.0 MDF.
      - 2) Finish: Carboline 890, 2 coats, 4.0 MDF per coat.
    - c. PPG:
      - 1) Primer: Amerlock 400 High-Solids Epoxy Coating, 1 coat, 4.0 MDF.
      - 2) Finish: Amerlock 400 High-Solids Epoxy Coating, 2 coats, 4.0 MDF per coat.
    - d. Valspar:
      - 1) Primer: 79-W-9 thinned 25 percent, 1 coat, 1.0 MDF.
      - 2) Finish: 89 Series, 2 coats, 4.0 MDF per coat.
- S. Wood Surfaces, Interior and Exterior:
- 1. Surface Preparation: Sand and seal.



2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: 151 Elasto Grip, 1 coat, 200 to 400 square feet per gallon.
      - 2) Finish: Series 2H Hi-Build Tneme-Gloss, 2 coats, 1.5 MDF per coat.
    - b. Carboline:
      - 1) Primer: Carbocrylic 120, 1 coat, 2.0 MDF.
      - 2) Finish: Carbocrylic 3359, 2 coats, 2.5 MDF per coat.
    - c. PPG:
      - 1) Primer: Amercoat 148 Synthetic Universal Primer, 1 coat, 2.0 MDF.
      - 2) Finish: Amercoat 220, 2 coats, 2.0 MDF per coat.
    - d. Valspar:
      - 1) Primer: 17-10-4 Undercoater, 1 coat, 2.0 MDF.
      - 2) Finish: 12 Series, 2 coats, 1.5 mils MDF per coat.
- T. Insulated Ferrous Metal Pipe, Interior, Temperatures below 200oF:
1. Surface Preparation: Solvent Clean, SSPC-SP1.
  2. Products and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Primer: Series 37H Chem-Prime, 1 coat, 2.0 MDF.
      - 2) Finish: Series 66 Epoxoline, 1 coat, 4.0 MDF per coat.
    - b. Carboline:
      - 1) Primer: Rustland Penetrating Sealer, 1 coat, 2.0 MDF.
      - 2) Finish: Carboline 890, 1 coat, 4.0 MDF.
    - c. PPG:
      - 1) Primer: Amercoat 68HS, 1 coat, 3.0 MDF.
      - 2) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF per coat.
    - d. Valspar:
      - 1) Primer: 13-F-28, 1 coat, 2.0 MDF.
      - 2) Finish: 89 Series, 1 coat, 4.0 MDF.
- U. Exposed Uninsulated PVC Piping and FRP Components, Interior and Exterior where painting is required.
1. Surface Preparation: As recommended by coating manufacturer.
  2. Product and Manufacturer: Provide one of the following:
    - a. Tnemec:
      - 1) Finish: Series 66 Hi-Build Epoxoline, 1 coat, 4.0 MDF.
    - b. Carboline:
      - 1) Finish: Carboline 890, 1 coat, 4.0 MDF.
    - c. PPG:
      - 1) Finish: Amercoat 385 Polyamide Epoxy, 1 coat, 4.0 MDF.
    - d. Valspar:
      - 1) 89 Series, 1 coat, 4.0 MDF.

3. A second finish coating of epoxy urethane, 3.0 MDF, shall be applied on all exterior PVC and FRP components (TNEMEC Series 74).
- V. Metal Pipe, Interior and Exterior, with Temperatures up to 250°F:
1. Surface Preparation:
    - a. Immersion Service:
      - 1) SSPC-SP10 Near-White Blast Cleaning.
    - b. Non-Immersion Service
      - 1) SSPC-SP6 Commercial Blast Cleaning.
  2. Products and Manufacturer: Provide one of the following:
    - a. Exterior Surfaces:
      - 1) Tnemec:
        - a) Primer: Series 66 Hi-Build Epoxoline at 4.0 mils dft.
        - b) Finish: Series 66 Hi-Build Epoxoline at 5.0 mils dft.
        - c) Finish (UV Exposure): Series 74 Endura-Shield, 4 mils dft.
      - 2) Carboline:
        - a) Primer: Carboline 893 at 3.0 mils dft, 1 coat.
        - b) Finish: Carboline 890 at 4.0 mils dft, 1 coat.
        - c) Finish (UV Exposure): Similar to TNEMEC above.
      - 3) PPG:
        - a) Primer/Finish: Amerlock 400 High Solids Epoxy Coating at 5.0 mils dft, 1 coat.
        - b) Finish (UV Exposure): Similar to TNEMEC above.
      - 4) Valspar:
        - a) 37A10 at 2 mils dft, 1 coat.
        - b) Finish (UV Exposure): Similar to TNEMEC above.
    - b. Interior Surfaces (SP10 Surface Preparation):
      - 1) Tnemec:
        - a) Primer: Tnemec 120-5002 at 15 mils dft, 1 coat.
        - b) Finish: Tnemec 120-5001 at 15 mils dft, 1 coat.
      - 2) Or Approved Equivalent.
- W. For Interior Concrete Floors (sealed):
1. Glidden:
    - a. Manufacturer's standard "water clear" emulsion-type breathing coating of acrylic resins (based on methyl methacrylate) in water recommended by manufacturer for application to interior concrete as a water-repellent coating; minimum 20 percent solids content.
    - b. Ashford Formula manufactured by Cure-Crete Chemical Company to seal and harden concrete floor.
- X. All outdoor fiberglass items including FRP protective tank shell on steel tanks, and structural components shall be coated as follows:
1. Surface Preparation:

- a. Brush off cleaning, SSPC-SP7.
  - b. Solvent cleaning, SSPC-SP1.
2. Products and Manufacturer:
- a. Tnemec:
    - 1) Primer: Series 66-Highbuild Epoxoline, 3.0-4.0 dry mils dft. Broom surface after coating has cured.
    - 2) Intermediate coat: Series-Highbuild Epoxoline, 3.0-4.0 dry mils dft.
    - 3) Finish: Series 75-Endura Shield, 3.0-5.0 mils dft.
  - b. Caroline, Valspar, PPG and Sigma equivalent coatings.
3. The intent of this coating specification is to obtain a polyurethane top coat for UV protection and cosmetic purposes. Primer and intermediate coats, as well as initial surface preparation shall be as recommended by the coating manufacturer for proper adhesion and serviceability on the fiberglass items to be painted.

### 3.7 FIELD QUALITY CONTROL

- A. CONTRACTOR shall be responsible for the following testing during coating operations:
- 1. Prior to start and during the coating application each day, temperature and humidity readings will be obtained. If the values obtained are not within the recommended temperature and humidity range described herein or as required by the coating manufacture, the coating application will not be allowed.
  - 2. Periodically check the wet film thickness during coating applications.
  - 3. Prepared records of the above tests and readings.
- B. Testing Agency: OWNER will engage a qualified testing agency to perform tests and inspections.
- 1. Minimum Dry Film Thickness (MDF) readings will be obtained after each coat of paint has been applied, and after final coat has been applied. A test will be made for every 25 square feet of surface and at locations designated by the ENGINEER. A minimum of three readings of the area around the location will be obtained. If the average of these readings indicates the MDF for the final coat is below the specified minimum, CONTRACTOR shall apply another coat in accordance with the manufacturer's instructions.
  - 2. The interiors of liquid containing structures and tanks will be tested for holidays after final coat application. Areas found to be defected shall have an additional coat applied.
- C. The coating system will be considered defective if it does not pass tests and inspections. When this occurs, the ENGINEER will specify corrective measures. The coating system will be retested, with the additional expense occurred charged to the CONTRACTOR. Refer to 01 40 00 "Quality Requirements" for addition information regarding retesting and reinspection and 01 70 00 "Execution Requirements" for correction of work.
- D. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
- 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified,

sealed, and certified in presence of Contractor.

2. Testing agency will perform tests for compliance of paint materials with product requirements.
  3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
- E. Prepare test and inspection reports.

### 3.8 COLOR CODING FOR PIPE

- A. Comply with the requirements of the Oklahoma DEQ as defined by Section 252 of the Oklahoma Statutes.
- B. See Schedule A in Section 10 90 00 "Identification, Stenciling, and Tagging".

### 3.9 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- E. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
- F. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
- G. Upon completion of the work remove all staging and scaffolding. Dispose of all sand, containers, ad rubbish in a suitable manner. Remove overspray, paint spots, oil or stains on adjacent surfaces. Leave the entire Project clean and acceptable.

**END OF SECTION**

**SECTION 10 14 00**  
**SIGNS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes installation of signs as described below and as shown in drawings:
  - 1. Ornamental signs removed during the course of construction.
  - 2. Warning signs at all electrical equipment.
  - 3. Hazardous materials signs.
  - 4. Other signs as shown and specified.
- B. All supplementary or miscellaneous items, such as bolts, mounting brackets, concrete bases, or any other devices necessary for a secure installation are to be furnished and installed as a part of this work.

**1.2 RELATED SECTIONS**

- C. SECTION 10 90 00 - IDENTIFICATION, STENCILING, AND TAGGING

**1.3 SUBMITTALS**

- D. Action Submittals
  - 1. Catalog Data. Submit manufacturer's catalog data showing colors dimensions, and materials of construction for each sign, as well as method of installation.

**1.4 QUALITY ASSURANCE**

- E. All signs and appurtenances described in this section shall be furnished by a single manufacturer.

**PART 2 - PRODUCTS**

**1.5 SIGNS**

- A. Signs specified herein shall be of one of the following materials, at the Contractor's option:
  - 1. Fiberglass equal to W. H. Brady Company, "Fibershield."
  - 2. LXSIGN as manufactured by Stonehouse Sign, Inc.
- B. Specific Products: Provide products of dimensions and colors equal to the following:
  - 1. Automatic Start Signs at all equipment: Stonehouse No. 184-9.
  - 2. Miscellaneous other signs are indicated by the Owner.

**PART 3 - EXECUTION**

**1.6 INSTALLATION**

- A. Install signs in same locations.
- B. Provide all necessary hardware for signs.
- C. Provide all necessary stands to erect signs.
- D. Replace signs to match existing.

**END OF SECTION**

**SECTION 10 90 00**  
**IDENTIFICATION, STENCILING, AND TAGGING**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. The CONTRACTOR shall furnish all labor, materials, tools, equipment, and perform all work and services for all identifications, stenciling and tagging as shown on the drawings and as specified.
- B. Items include but are not necessarily limited to the following areas of work:
  - 1. Paint and provide identification signs for all exposed piping, ductwork, and conduits in accordance with Schedule A at the end of this section.
  - 2. Provide identification tags and stenciling for all equipment, valves, instrumentation, and electrical components, including existing equipment and valves. Specific valve and equipment tag information shall be furnished by the OWNER.
- C. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, including connections and mounting hardware, necessary wfor a sound, secure, and complete installation shall be furnished and installed as part of this work.

**1.2 QUALITY ASSURANCE**

- A. Unless otherwise specified, all equipment and valves including mechanical, process, electrical, and instrumentation are required to be identified.
- B. Unless otherwise specified, openings, accesses and related locations are required to be identified.
- C. Coordination, development, and initiation of identification, marking, and tagging systems and determination of separation of subcontractor's and manufacturer's corresponding responsibilities is the sole responsibility of the CONTRACTOR.
- D. Referenced Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
  - 1. ANSI A13.1, Scheme for the Identification of Piping Systems.
  - 2. Great Lakes - Upper Mississippi River Board of State Sanitary Engineers (Ten States Standards). Recommended Standards of Waste Treatment Works latest edition, Recommended Color Scheme for Piping. Three Great Lakes - Upper Mississippi River Board of State Sanitary, 1968 Edition, Addendum No. 6, Painting of Water Works Piping for Public Water Supplies.
  - 3. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
  - 4. SSPC Volume 2, System and Specifications, Surface Preparation Guide and Paint Application Specifications.

**1.3 SUBMITTALS**

- A. Submit identification register acknowledging all designated or scheduled equipment, instruments, gauges, valves, HVAC equipment, mechanical and electrical equipment. All items on register shall be tagged. Numbering system will be as shown on P&ID drawings.
- B. Develop and submit full identification register acknowledging equipment, valves, instruments, mechanical equipment and electrical equipment which is not designated or

scheduled in drawings and specifications. Provide identifications compatible but not conflicting with designated or scheduled equipment and related items. All items on register shall be tagged.

- C. Submit assurances that subcontractors and manufacturers have been advised of register requirements.
- D. Update identification register immediately prior to final acceptance of work.
- E. Pipe Markers and Safety Signs:
  - 1. Submit for approval samples of each type of marker and sign specified.
  - 2. Submit copies of manufacturer's technical brochure including color chart and list of standard signs.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Acceptable Manufacturers: Provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Seton Identification Products.
  - 3. Or approved equal.
- B. General:
  - 1. Pipe marker and safety sign materials shall withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining or other damage.
  - 2. Piping markers shall be formed from laminated plastic. All printing shall be sealed with a formed butyrate plastic film. Markers for piping up to 6-inch diameter shall be pre-formed to completely wrap around the pipe requiring no adhesive. Markers for pipes over 6-inch diameter shall be performed to the contour of the pipe and attached with stainless steel spring fastener.
  - 3. Each marker shall consist of at least one legend descriptive of the function of the pipe, as listed in Schedule A, and a directional arrow.
  - 4. The size of lettering and marker shall conform to ANSI A13.1.
  - 5. Location of markers:
    - a. Adjacent to each valve and "T" connection.
    - b. At each branch and riser takeoff.
    - c. At each pipe passage through a wall, floor and ceiling.
    - d. On all horizontal and vertical pipe runs at 20-foot intervals.
  - 6. Safety signs shall be 18 inches by 24 inches formed from semi-rigid butyrate or polyethylene. They shall be attached with 4 stainless steel screws or similar fastener for substrate.

### 2.2 COLORS AND FINISHES

- A. Color Schedule: Paint colors will be selected by the ENGINEER from the approved manufacturer's color chips.
- B. Color Coding: In general, all color coding of piping, ducts and equipment shall comply with



applicable standards of ANSI A13.1 and OSHA 1910.144 and shall meet the TCEQ requirements of 30 TAC 217.

- C. Piping and Sign Color Code: Refer to Schedule A at end of section.

## 2.3 IDENTIFICATION SYSTEMS

- A. Tagging system and stenciling system shall be selected by the CONTRACTOR. Valve tags shall include identification number, process, valve type, direction to open and number of turns to open.
- B. Tagging of Equipment:
  - 1. Yard Valves: Identify with brass marking plate (minimum 1/8-inch thick) with embedment for placement in concrete.
  - 2. Yard Slide Gates: Provide stainless steel plates with black enamel filled embossed lettering. Provide minimum plate of 2-1/2 inches with minimum letter height of 2 inches. Attach to gate frames at visible location by stainless steel fasteners.
  - 3. Process valves, mechanical valves, instrumentation, and mechanical and process equipment (interior/exterior):
    - a. Provide minimum 2-1/2-inch stainless steel plate with black enamel filled lettering.
    - b. Attach to valves by nylon strap or stainless steel nonremovable beaded chains or to equipment by stainless steel fasteners.
    - c. Provide general color scheme of tagging for listed items with black letter and numbers on background as follows:

Instrumentation tags	White
Process valves and equipment tags	Red
Water valves tags	Blue
Mechanical valve and equipment tags	Green
Electrical equipment	Yellow
  - 4. Electrical Equipment: Observe requirements and provisions stated in Division 26 of these specifications.
- C. Identification of piping, process tanks, galleries, pits, chemical liquid or solid storage tanks and silos, storage vessels, air ducts and similar items.
  - 1. Use Tagging Systems by W. H. Brady Company, as follows:
    - a. Vinyl film cloth for interior non-insulated piping systems (Category B-500).
    - b. Thin film for insulated piping systems (Category B-350).
    - c. All weather film for outdoor exposed piping (Category B-350). Provide flow arrows, banding tape, and numbering and lettering of same materials for corresponding applications.
  - 2. Use stenciling systems in accordance with accepted practices.
  - 3. Tagging and stenciling letter and number heights shall be:
    - a. Minimum 1/2 inch for piping less than 1-inch diameter.
    - b. Minimum 1-1/8 inches for piping 1 inch to 3-inch diameter.
    - c. Minimum 2-1/4 inches for piping greater than 3-inch diameter to 24-inch.
    - d. Minimum 3-1/2 inches for piping greater than 24-inch diameter and all process tanks, galleries, pits, chemical, liquid, or solid storage tanks and silos, storage

vessels, mechanical heat exchangers, ducts, blowers, and similar related items.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Protected printed surfaces and adjacent work and materials by suitable covering during progress of work.
- B. Insure hardware, accessories, plates, fixtures, finished work and similar items are removed or protected.
- C. Paint or apply not less than one band on any length of pipe. Follow a clean-cut line around entire pipe.
- D. Install piping markers and safety signs only after all painting and finish work has been completed. This does not include temporary "wet paint" or construction safety signs.
- E. Provide arrows and identification stickers:
  - 1. At 20'-0" maximum centers along continuous lines.
  - 2. At changes in direction (route), valves, risers, joints, machinery, or equipment.
  - 3. Where pipes, ducts pass through floor, wall, ceiling, cladding assemblies and the like obstruction on both sides of assembly.
  - 4. Apply markers on both sides of pipe and where view is not obstructed.
  - 5. Arrow markers must point away from pipe markers and in flow direction, if flow in both directions use double-headed arrow markers.
- F. Identify piping and ductwork including interior or exterior, exposed or covered, insulated or not, including pipes and ducts in open or covered floor or ceiling ducts or spaces.
- G. Apply tapes in uniform manner and parallel to piping and ducts.

#### 3.2 ATTACHMENTS

- A. Schedule A – Piping and Sign Color Code

**END OF SECTION**

<b>SCHEDULE A</b>			
<b>PIPING AND SIGN COLOR CODE</b>			
<b>PIPING AND LEGEND</b>	<b>PIPING COLOR</b>	<b>LETTERING COLOR</b>	<b>BACKGROUND COLOR</b>
<b>WATER</b>			
Raw Water	Tan	Black	Yellow
Air Conditioning Water	Blue	White	Green
Domestic Hot Water	Blue w/	Black 6" Red Bands	Yellow
Plant Water/Reclaimed/NPW	Purple	Black	Green
Potable Water	Light Blue	Black	Green
Effluent after clarification	Dark Green	Black	Green
<b>AIR AND GAS</b>			
Blower Air	Green	White	Blue
Chlorine Gas	Yellow	Yellow	Black
Compressed Air	Light Green	Yellow	Black
Instrument Air	Light Green w/	Dark Green Bands	
Mixed Gas	Red	Black	Yellow
Natural Gas	Red	Black	Yellow
Propane Gas	Red	Black	Yellow
Sulfur Dioxide	Lime Green	Black Yellow Bands	Yellow
Sludge Gas, HP	Red	Black	Yellow
Sludge Gas, LP	Red	Black	Yellow
Waste Gas	Red	Black	Yellow
Blower Lube	White	White	Blue
Grease	White	Black	Green
Foul (odorous) Air	Beige	Yellow	Black
Oxygen Gas	N/A	Green	White
Ozone	Stainless steel w/	White Bands	
<b>CHEMICALS</b>			
Aluminum Sulfate (Solution)	Yellow w/	Black Green Bands	Yellow
Aluminum Sulfate (Liquid)	Yellow w/	Black Orange Bands	Yellow
Chlorine Liquified	Yellow	Black	Yellow
Chlorine Solution	Yellow	Black	Yellow
Ferric Chloride	Light Brown w/	Black Red Bands	Yellow
Ferric Sulfate	Brown w/	Yellow Bands	
Ferric Sulfide	Yellow	Black	Yellow
Ferrous Chloride	Yellow	Black	Yellow
Sodium Hypochlorite	Yellow	Black	Yellow
Sulphur Dioxide	Lime Green w/	Black Yellow Bands	Yellow

Polymer	White w/	Green Bands	
<b>PROCESS</b>			
Grit	Brown	Black	Green
Groundwater Drain	Tan	White	Black
Drain		Green	Black Green
Scum	Brown	Brown	Green
Sewage	Gray	Black	Green
Sludge	Brown	Black	Green
Digester Tank Vent	Brown	Black	Green
Oxygenated Wastewater	Grey	White	Green
<b>VENTS</b>			
High and Low Temperature	Yellow	Black	Yellow

Colors listed above shall be similar to the following standard colors by Tnemec Company:

1. Light Blue: 17BL "Horizon Blue"
2. Blue: 59HT "Safety Blue"
3. Red: 06SF "Safety Red"
4. Gray: 33GR " Gray"
5. Green: BS28 "Safety Green"
6. Lime Green: 46GN "Limeade"
7. Light Green 09SF "Spearmint/Safety Green"
8. Tan: TRA Twine (Tan) (Tnemec has on file)
9. Yellow: 02SF "Safety Yellow"
10. White: 00WH "White"
11. Purple: 13SF "Purple Mountain's Majesty"
12. Brown: TRA Outside Equipment Brown (Tnemec has on file)
13. Light Brown: 06BR "Amber Canyon"

**SECTION 26 00 00**  
**ELECTRICAL GENERAL PROVISIONS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The work includes, but is not limited to, the following principal systems and equipment:
1. Motors.
  2. Grounding and Lightning Protection.
  3. 208/120 V distribution.
  4. Panelboards.
  5. Raceways.
  6. Transformers.
  7. Lighting fixtures and lamps.
  8. 480-V distribution.
  9. Miscellaneous control.
  10. 480-V motor control centers.
  11. Variable Frequency Controllers.

**1.2 REFERENCES**

- A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of the applicable rules, regulations, requirements, and specifications of the following:
1. Local laws and ordinances.
  2. State and Federal Laws.
  3. National Electrical Code (NEC).
  4. State Fire Marshal.
  5. Underwriters' Laboratories (UL).
  6. National Electrical Safety Code (NESC).
  7. American National Standards Institute (ANSI).
  8. National Electrical Manufacturer's Association (NEMA).
  9. National Electrical Contractor's Association (NECA) Standard of Installation.
  10. Institute of Electrical and Electronics Engineers (IEEE).
  11. Insulated Cable Engineers Association (ICEA).
  12. Occupational Safety and Health Act (OSHA).
  13. National Electrical Testing Association (NETA).
  14. American Society for Testing and Materials (ASTM).
- B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.
- C. Product Quality: All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project.

Proof of purchase documents shall be provided upon request. Utilize products of a single MANUFACTURER for each item.

### 1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED

### 1.4 SUBMITTALS

#### A. Action Submittals:

##### 1. Product Data:

- a. Submit manufacturer's descriptive literature and product specifications for each product.
- b. Submittal data must show MANUFACTURER's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.
- c. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated.

##### 2. Shop Drawings:

- a. Indicate typical layout including dimensions.
- b. Submittals are required on all products and items to be installed on this project.
- c. Submit detail drawings of special accessory components not included in the manufacturer's product data.

##### 3. Terminal Connection Diagrams:

- a. Submit terminal connection diagrams for approval prior to any wire installation.
- b. Submit finalized terminal connection diagrams at the end of the Contract.

#### B. Informational Submittals:

##### 1. Source Quality Control Submittals:

##### 2. Field / Site Quality Control Submittals:

##### 3. Sustainable Design Submittals:

##### 4. Special Procedure Submittals:

##### 5. Qualification Statements:

##### 6. Previous Installations List:

##### 7. Samples:

##### 8. Certificates:

- a. Supplier Certificates – Refer to Item 3.10 in this Section.

##### 9. Manufacturer's Instructions / Reports:

#### C. Closeout Submittals:

##### 1. Maintenance Contracts:

##### 2. Operation and Maintenance Data:

##### 3. Bonds:

##### 4. Warranty Documentation:

5. Record Documentation: Prepare and maintain Project Record Documents in accordance with Division 1 Section 01 78 10 - Project Record Documents and the

following:

- a. At the job site, maintain a set of white prints of the contract drawings.
  - b. At the job site, maintain a set of equipment terminal connection diagrams.
  - c. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.
  - d. Mark the drawings with a colored pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.
  - e. Delivery: Submit Project Record Documents in accordance with Division 1 Section 01 78 10 - Project Record Documents.
6. Sustainable Design Closeout Documentation:
  7. Software:
- D. Maintenance Material Submittals:
1. Spare Parts / Extra Stock Materials:
  2. Tools and Software:

## 1.5 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
1. Refer to Section 01 40 00 - Quality Requirements.
  2. Regulations: Work, materials and equipment must comply with the latest rules and regulations of the following:
    - a. National Electrical Code (NEC).
    - b. National Electrical Safety Code (NESC).
    - c. Occupational Safety and Health Act (OSHA).
    - d. State and federal codes, ordinances and regulations.
    - e. Local Electrical Code.
  3. Discrepancies:
    - a. The Plans and Specifications are intended to comply with listed codes, ordinances, regulations and standards.
    - b. Where discrepancies occur, immediately notify the ENGINEER in writing and ask for an interpretation.
    - c. Should installed materials or workmanship fail to comply, the CONTRACTOR is responsible for correcting the improper installation.
  4. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirement, provide those specified or shown.
- B. Qualifications:
1. Suppliers:
    - a. Company specializing in supplying products specified in this Section with minimum 5 years documented experience.
    - b. All equipment of each type specified in this section shall be supplied by a single SUPPLIER who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed,

- constructed, and installed in accordance with the best practices and methods.
- c. SUPPLIER shall maintain a complete stock of spare parts commonly needed for the equipment specified and shall be capable of shipping spare parts within 48 hours of request.
  - d. SUPPLIER shall furnish all equipment with a stainless steel nameplate securely affixed in a conspicuous place on the equipment showing the equipment ratings, serial number, model number, equipment supplier name, and other pertinent nameplate data.
2. An acceptable CONTRACTOR for the work under this division must have personnel with experience, training, and skill to provide a practical working system. The CONTRACTOR shall have previous water and wastewater experience with at least five years in business.
- a. The CONTRACTOR shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.
  - b. The systems must have served satisfactorily for not less than three years.
  - c. The superintendent must have had experience in installing not less than three systems.
  - d. The CONTRACTOR shall submit qualifications of his firm and resumes of his personnel who will work on this project.
3. Field Representative:
- a. The SUPPLIER shall furnish a qualified field representative for the time indicated in this Section. Field representatives shall be factory-employed personnel and have a minimum of 2 years' experience with the operation of and training on this type of equipment. Sales representatives will only be considered acceptable service technicians if they have 3 years' experience with the operation of and training on this type of equipment from the SUPPLIER being supplied and have started up 15 units of a similar size and type from the SUPPLIER. The field representative shall submit a resume for approval before startup assistance can be provided. For each training event two separate pre-startup training sessions shall be performed, one in the early morning and one in the late afternoon. Two separate post-startup training sessions shall be performed, one in the early morning and one in the late afternoon. CONTRACTOR shall coordinate the scheduling of such training and startup assistance with OWNER'S personnel. A typed outline shall be handed out at each training session and, at a minimum, will include normal operating parameters, alarms, and maintenance.
4. Testing Agencies:
5. Licensed Professionals:
- C. All electrical work shall be performed by workers skilled in the electrical trade and licensed for the work by the local authority.
  - D. A licensed Master Electrician will be required for constructing, installing, altering, maintaining, repairing or replacing any electrical wiring, apparatus, or equipment on any voltage level. A licensed Master Electrician or a licensed Journeyman Electrician is required to be on the job site during the performance of any electrical work.
  - E. All cable splicing methods and materials shall be of the type recommended by the splicing



materials MANUFACTURER for the cable to be spliced and shall be approved by the ENGINEER prior to installation.

- F. All materials and equipment shall be installed in accordance with the approved recommendations of the MANUFACTURER and the best practices of the trade, and in conformance with the Contract Documents. The CONTRACTOR shall promptly notify the OWNER in writing of any conflict between any requirements of the Contract Documents and MANUFACTURER's directions and shall obtain written instructions from the OWNER before proceeding with the work. Should the CONTRACTOR perform any work that does not comply with the MANUFACTURER's directions or such written instructions from the OWNER, he shall bear all costs incurred in correcting deficiencies.
- G. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the MANUFACTURER's name, trademark and ASME, UL, or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a MANUFACTURER regularly engaged in the production of the required type of equipment and shall be supported by a service organization that is, in the opinion of the OWNER, reasonably convenient to the site.
- H. It is the responsibility of the CONTRACTOR to ensure that items furnished fit the space available with adequate room for proper operation and maintenance. He shall make measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the Plans, Specifications and Contract Documents.
- I. The CONTRACTOR shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the OWNER.
- J. When the ENGINEER has reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the CONTRACTOR to install the equipment to operate properly and in accordance with the intent of the Plans and Specifications, and he shall provide any additional equipment and materials that may be required. The CONTRACTOR shall be responsible for the proper location of roughing-in and connections by other trades. All changes shall be made at no increase in the Contract Amount or additional costs to other trades.
- K. The CONTRACTOR shall support the installation of all equipment, plumb, rigid and true to line. The CONTRACTOR shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store all components to be installed under this section in accordance with the SUPPLIER'S written Pre-Installation Delivery, Storage, and Handling Instructions and the requirements of Section 01 60 00 - Product Requirements.

#### 1.7 SITE CONDITIONS

- A. Environmental Conditions:

1. All equipment including controls and drives specified herein shall be specifically designed to be installed for this service and the environment encountered in this installation, unless noted otherwise.
  2. The environment will be moist and corrosive at wastewater facilities exhibiting hydrogen sulfide and other corrosive gases encountered in municipal wastewater treatment and pumping facilities.
  3. All equipment shall be designed and capable of operation outdoors at ambient temperatures of 10 degrees F to 110 degrees F.
  4. Equipment shall be compatible with heat tracing and insulation, which will be furnished and installed by the CONTRACTOR. SUPPLIER shall design piping systems with ample clearances and material compatibility to accept required heat tracing and insulation. If additional freeze protection beyond heat tracing and insulation is required, it shall be furnished by the SUPPLIER. SUPPLIER shall coordinate with the CONTRACTOR to provide direction on where heat tracing is required, and shall verify that the CONTRACTOR has provided adequate heat tracing and insulation during startup activities.
- B. Existing Conditions:
1. CONTRACTOR shall verify actual dimensions of openings, adjacent facilities and equipment, utilities, and related items by field measurements before fabrication, as applicable.

## 1.8 WARRANTY

- A. Manufacturer Warranty:
1. Refer to Section 01 78 26 - Warranties for Special Equipment Warranty.

## 1.9 CONTRACT DOCUMENTS

- A. Intent:
1. The intent of the contract drawings or Plans is to establish the types of systems and functions; the drawings will not specifically indicate each item essential to the functioning of the system.
  2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
  3. Install the work complete, including minor details necessary to perform the function indicated.
  4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the ENGINEER.
  5. It is also the intent of these Contract Documents that the electrical and process system CONTRACTOR coordinate with each other in order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the Plans.
- B. Discrepancies:
1. Review pertinent drawings and adjust the work to conditions shown.
  2. Where discrepancies occur between Plans, Specifications, and actual field conditions, immediately notify the ENGINEER for his interpretation.

3. Dimensions on electrical drawings shall be verified with structural, architectural and mechanical drawings.
- C. Outlet and Equipment Locations:
1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings.
  2. Review with the ENGINEER any proposed changes in outlet or equipment location.
  3. Relocation of outlets before installation, up to 3 feet from the position indicated, may be directed by OWNER without additional cost.
  4. Remove and relocate outlets placed in an unsuitable location, when so requested by the ENGINEER.

#### 1.10 SYSTEM RESPONSIBILITY

- A. The ELECTRICAL CONTRACTOR shall be responsible for:
1. Complete systems in accordance with the intent of these Contract Documents.
  2. Coordinating the details of facility equipment and construction for all Specification Sections which affect the work covered under Division 26, Electrical.
  3. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  4. Coordinate the work with the PLANT CONTROL SYSTEM INTEGRATOR.
    - a. The PLANT CONTROL SYSTEM INTEGRATOR shall furnish and install the primary and secondary instruments, i.e., level element and level indicating transmitter, flow transmitter (flow tube by others), headloss transmitters, etc. Refer to Loop Drawings.
    - b. The conduit and wiring to and from the instruments shall be furnished and installed by the ELECTRICAL CONTRACTOR. Termination in the instrument shall be by PLANT CONTROL SYSTEM INTEGRATOR.
    - c. All terminations in the control panel shall be by PLANT CONTROL SYSTEM INTEGRATOR.
    - d. ELECTRICAL CONTRACTOR shall:
      - 1) Provide termination drawings for PLANT CONTROL SYSTEM INTEGRATOR.
      - 2) Provide equipment pad for control panels, consoles and instrument panels shall be furnished by the Electrical CONTRACTOR.
      - 3) Coordinate testing of the electrical system being furnished and shall be responsible for the equipment supplied.
      - 4) Present at time of the instrument system testing and start-up and responsible for the coordination of the facility testing with the PLANT CONTROL SYSTEM INTEGRATOR.
      - 5) Coordinate the interface requirement between each starter and control panel furnished under this Contract with the PLANT CONTROL SYSTEM INTEGRATOR.
    - e. Written proof shall be furnished to verify a clear understanding has been reached between the ELECTRICAL CONTRACTOR and the PLANT CONTROL

SYSTEM INTEGRATOR for each control loop requirement, i.e., type of contacts (momentary, maintained), interface relay requirement, number of wires, terminal marking, control schematic information, and wiring diagrams.

- B. Electrical Drawings showed only general locations of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.
- C. Submit to the ENGINEER in writing details of any necessary, proposed departures from these Contract Documents. Submit such request as soon as practicable, and within ten (10) days after award of the Contract. Make no such departures without written approval of the ENGINEER.
- D. Dimensions on electrical drawings shall be verified with structural, architectural, and mechanical drawings.
- E. Where the CONTRACTOR is submitting a packaged system; the system shall comply with the requirements of the electrical specifications, including field cables, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, and motors. Deviations shall not be accepted, unless pre-approved. Control centers and special control cabinets wired to terminal blocks shall include the MANUFACTURER's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.
- F. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be pre-arranged with the ENGINEER and OWNER. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the ENGINEER. Include costs for temporary wiring and overtime work required in the Contract price. Remove temporary wiring at the completion of the work.

## PART 2 - PRODUCTS

### 2.1 PRODUCT REQUIREMENTS

- A. Condition: Materials and equipment provided under these Specifications shall be new products of MANUFACTURERS regularly engaged in production of such equipment. Provide the MANUFACTURER's latest standard design for the type of equipment specified.
- B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.
- C. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Do not provide equipment which will not suit arrangement and space limitations.
- D. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.
- E. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, and rigid aluminum or Type 316 stainless steel metal framing and supports, and other items as indicated on the Plans.

## 2.2 SUBSTITUTIONS

- A. Refer to Division 1 General Requirements for substitution requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLER - NOT USED

### 3.2 EXAMINATION - NOT USED

### 3.3 PREPARATION

#### A. Protection of Equipment

1. Moisture:
  - a. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.
  - b. Apply protection immediately on receiving the products and provide continuous protection.
  - c. Store all equipment indoors in dry, well ventilated and heated space.
2. Clean: Keep products clean by elevating above ground or floor and by using suitable coverings.
3. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
4. Finish: Protect factory finish from damage during construction operations and until final acceptance of the project.

### 3.4 INSTALLATION

- A. Refer to Section 01 70 00 - Execution Requirements.
- B. Cooperation with Other Trades:
  1. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.
  2. Coordinated equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
- C. Workmanship: Work must be performed by workers skilled in their trade. The installation must be complete whether the work is concealed or exposed.
- D. Concrete Equipment Pads:
  1. Install minimal 4-inch thick concrete foundation pads for indoor floor mounted equipment, except where direct floor mounting is permitted by the ENGINEER.
  2. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment.
  3. Trowel pads smooth and chamfer edges to a 1-inch bevel.

4. Provide dowels in slab, and rebar between the dowels.
  5. Pads must drain away from the equipment.
  6. Secure equipment to pads as recommended by the MANUFACTURER.
- E. Setting of Equipment:
1. Equipment must be leveled and set plumb.
  2. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 1/2 inch by means of corrosion resistant spacers or by 3 inches of air for freestanding units.
  3. Use corrosion resistant bolts, nuts and washers to anchor the equipment.
- F. Sealing of Equipment:
1. Permanently seal outdoor equipment at the base using grout in accordance with Section 03 60 00 - Grout, Non-Shrink.
  2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.
  3. Use stainless steel or copper mesh with openings not larger than 1/16-inch squares for screened openings.
  4. Seal small cracks and openings from the inside with silicone sealing compound.
- G. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
  2. Where exposure is necessary to the proper function.
  3. Where size of materials and equipment precludes concealment.
- H. Application: Unless otherwise indicated, power will be utilized as follows:
1. Motors 1-2 horsepower and smaller: 120 V, single-phase.
  2. Incandescent lighting, convenience outlets, special outlets and fluorescent lighting: 120 V, single-phase.
- I. Equipment and Device Marking
1. Nameplates:
    - a. Externally mark electrical equipment by means of suitable nameplates identifying each and the equipment served.
    - b. Provide each piece of equipment with a black phenolic nameplate with 3/16-inch high white lettering secured to front of equipment. For nameplate size, refer to Section 26 05 53 - Identification for Electrical Systems.
    - c. Supply blank nameplates for spare units and used spaces.
    - d. Actual nameplate legend, which may consist of up to three lines, will be provided to the ENGINEER on submittals.
  2. Nameplate Fasteners: Fasten nameplates to equipment only by means of appropriate noncorroding screws and as specified in Section 26 05 53 - Identification for Electrical Systems.
  3. Nameplate Information: In general, the following information is to be provided for

the types of electrical equipment as listed.

- a. Switchgear, Motor Control Centers and Distribution Panelboards: On the mains, identify the piece of equipment, the source and voltage characteristics, i.e., 480 V, 3PH, 3 W, etc. For each branch circuit protective device, identify the load served.
  - b. Transformers: Identify the service source and load served.
  - c. Panelboards: Identify the service source, panelboard designation and voltage characteristics.
4. Panelboards:
- a. Prepare a neatly typed circuit directory behind clear heat-resistant plastic for each panelboard.
  - b. Identify circuits by equipment served and by room numbers, where room numbers exist.
  - c. Use equipment names and room numbers selected by the ENGINEER; names and numbers may be different from those shown on Drawings.
  - d. Indicate spares and spaces with light, erasable pencil markings.
5. Boxes, Small Equipment and High Equipment:
- a. Pull boxes and similar items may be marked with Dymo No. 158-4 vinyl embossing tape with adhesive back in lieu of nameplates. Use Dymo No. 7123 perma-stick liquid adhesive with the tape. Tape color, placement and spacing must be approved by the ENGINEER before starting this work. Individually mounted disconnect switches and motor starters shall be marked with phenolic nameplates attached with stainless steel.
  - b. Provide identification stencils for high voltage equipment and raceways with the legend "DANGER HIGH VOLTAGE." Mark all exposed high voltage raceways every 25 feet.
6. Power Receptacles: Use nameplate or engraved plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 V with circuit No., voltage and phases.
7. Wall Switches: Engrave the switch plate of the switch with the function of the switch.

### 3.5 SYSTEM STARTUP

- A. Startup of the facility shall be in accordance with Section 01 75 25 - Equipment Testing and Startup.

### 3.6 CUTTING AND PATCHING

- A. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of ENGINEER. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition.

### 3.7 LOAD BALANCE

- A. The Drawings and Specifications indicate circuiting to electrical loads and distribution

equipment. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and related items.

### 3.8 MOTOR ROTATION

- A. Before and after final service connections are made, check and correct the rotation of motors.
- B. Coordinate rotation checks with the ENGINEER and the CONTRACTOR responsible for the driven equipment. Submit a written report to the ENGINEER for each motor verifying that rotation has been checked and corrected.

### 3.9 CLEANING AND TOUCH-UP PAINTING

- A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching, as nearly as possible, the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the ENGINEER.

### 3.10 CLOSEOUT ACTIVITIES

- A. Demonstration
- B. Training
- C. Equipment Supplier Certificates
  - 1. Provide Equipment Supplier Certificate(s) of installation stating the equipment is installed per the manufacturer's recommendations and in accordance with the Drawings and Specifications.
  - 2. Provide Equipment Supplier Certificate(s) of Performance stating the equipment meets or exceeds the performance requirements as defined herein.

**END OF SECTION**



**SECTION 26 02 00  
UTILITIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Furnish and install necessary materials and make arrangements for the connection of utilities for the project. The specified utilities are electrical and natural gas services.

**1.2 REFERENCES**

- A. Division 26 Electrical Sections for the requirements for electrical components.
- B. Comply with all service installation standards of the serving utility companies.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Product Data: For each specified utility service, provide construction details, material descriptions, and utility company requirements.

**1.5 QUALITY ASSURANCE - NOT USED**

**1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED**

**1.7 SITE CONDITIONS - NOT USED**

**1.8 WARRANTY - NOT USED**

**PART 2 - PRODUCTS**

**2.1 ELECTRICAL SERVICE**

- A. CONTRACTOR shall coordinate with the utility company and provide the required service connection(s) using approved materials at the location(s) indicated on the Drawings. All connection costs to be paid by the CONTRACTOR.

**2.2 NATURAL GAS SERVICE**

- A. CONTRACTOR shall coordinate with the utility company and provide the required service connection(s) using approved materials at the location(s) indicated on the Drawings. All connection costs to be paid by the CONTRACTOR.
- B. Connection Requirements:
  - 1. Location of the service entrance must be coordinated with the ENGINEER / Owner. Provide materials and equipment to connect the Project service to the system.
  - 2. Natural Gas utility for generator set shall meet the following:
    - a. Feed Pressure: Operating fuel pressure for natural gas shall be between 7.0 and 11.0 inches of H<sub>2</sub>O.

**PART 3 - EXECUTION**

**3.1 UTILITY SERVICE CONNECTION**

- A. Install the utility services as specified, complying with the utility company requirements, and at the locations indicated on the Drawings.
- B. CONTRACTOR to install primary underground duct bank, along with a spare conduit with pull cord at the designated location(s). Duct bank to be installed meeting both the electric utility company and Owner requirements.
- C. CONTRACTOR, following approved construction sequencing, the electrical equipment shall be energized on time. Delay to the startup shall not be caused due to the lack of the electrical CONTRACTOR's coordination.

**END OF SECTION**

**SECTION 26 05 19**  
**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.
  - 3. Sleeves and sleeve seals for cables.

**1.2 REFERENCES**

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**PART 2 - PRODUCTS**

**2.1 CONDUCTORS AND CABLES**

- A. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. Single Conductors:
  - 1. Unless otherwise indicated, all conductors shall be copper and shall be stranded. Solid conductors shall be allowed on 120-V lighting and receptacle circuits.
  - 2. Utilize only conductors meeting applicable requirements of NEMA WC 3, WC 5, WC 7, and ICEA S-19-81, S-61-402, and S-66-524.
  - 3. Insulation Requirements:
    - a. Conductor sizes No. 6 and larger provide conductors with type RHH or RHW.

- b. Conductor sizes smaller than No. 6 provide conductors with XHHW.
  - c. For lighting and receptacles, provide conductors with THHN or THWN.
4. Unless noted otherwise, conductor sizes indicated are based on copper conductors. Do not provide conductors smaller than those indicated.
  5. Where flexible cords and cables are specified, provide Type SO, 600 V with the number and size of copper conductors indicated.
- C. Multi-Conductor Cable:
1. Provide cable that is UL listed Type TC and conforms to the requirements of UL 1277 and NEC Article 340, or UL listed Power Limited Circuit Cable that conforms to the requirements of NEC Article 725. Provide cables permanently and legibly marked with the Manufacturer's name, the maximum working voltage for which the cable was tested, the type of cable, and labeled UL (or submit evidence of UL listing).
  2. 600 V Multi-Conductor Control Cable, Type TC:
    - a. General: Multi-conductor control circuit interconnection cable with ground. Suitable for installation in open air, in cable trays, conduit, or other approved raceways. Minimum cable temperature rating 90°C dry locations, 75°C wet locations. Passes vertical tray flame test.
    - b. Individual Conductors: No. 14 AWG, 7-strand copper.
    - c. Insulation and Jackets: Provide conductors insulated with flame retardant ethylene propylene rubber, UL rated VW-1. Conductors identified by colors per ICEA Method 1 K2 (no greens and whites) and assembled to ICEA standards. Outer jacket flame retardant, sunlight resistant and oil resistant, chlorosulfonated polyethylene (CSPE) with nominal thickness per ICEA standards.
  3. 600 V Multi-Conductor Power Cable, Type TC:
    - a. General: Three-conductor or 4-conductor, with ground and overall jacket suitable for installation in open air, cable trays, conduit, or other approved raceways. Minimum cable temperature rating 90°C dry locations, 75°C wet locations.
    - b. Individual Conductors: Class B stranded, coated, or uncoated copper.
    - c. Insulation and Jackets: Provide conductors insulated with flame retardant ethylene propylene rubber, UL rated VW-1. Conductors identified by colors per ICEA Method 1 K2 (no greens and whites) and assembled to ICEA standards. Outer jacket flame retardant, sunlight resistant, and oil resistant, chlorosulfonated polyethylene (CSPE) with nominal thickness per ICEA standards.
  4. Single Pair (600 V No. 16 AWG Twisted, shielded Pair Instrumentation Cable, Type TC):
    - a. General: Single pair instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90°C dry locations, 75°C wet locations.
    - b. Individual Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B8, 20 AWG, 7-strand copper drain wire.
    - c. Insulation and Jacket: Each conductor 15-mil nominal PVC and 4-mil nylon

insulation. Pair conductors pigmented black and red. Jacket flame-retardant and sunlight and oil resistant PVC with 45-mils nominal thickness. Shield 1.35 mil aluminum, Mylar overlapped, to provide 100% coverage.

- d. Dimension: 0.31 inch nominal
- 5. Multi-pair (600 V No. 16 AWG, Multi-twisted Shielded Pairs with a Common Overall Shield Instrumentation Cable, Type TC):
  - a. General: Twisted, shielded pairs of instrument cables, grouped in a single cable with an overall shield, designed for use as instrumentation, process control, and computer cable. Suitable for installation in cable tray, conduit, or other approved raceways. Minimum cable temperature rating shall be 90°C dry locations, 75°C wet locations.
  - b. Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B8. Copper drain wires. Pair drain wire size AWG 20; group drain wire size AWG 18.
  - c. Insulation and Jacket: Each conductor 25-mil flame retardant ethylene propylene pigmented black and red with red conductor numerically printed for group identification. Outer jacket flame retardant and sunlight and oil resistant chlorinated polyethylene (CPE) with nominal thickness. Individual pair shield 1.35-mil aluminum-mylar with tin plated copper drain wire. Group shield 2.35-mil aluminum-mylar, overlapped for 100% coverage.
- D. Type P Four Conductor Power Cable
  - 1. General: Four (4) insulated power conductors, armored and sheathed for demanding environments of offshore drilling and petroleum facilities.
    - a. Individual Conductors: Soft annealed flexible stranded tinned copper per IEEE 1580 Table 11.
    - b. Insulation: Flame retardant cross-linked polyolefin, meeting the requirements for Type P of IEEE 1580 and Type X110 of UL 1309/CSA C22.2 No. 245.
    - c. Jacket: Black, active grade, flame retardant, oil, abrasion, chemical and sunlight resistant thermosetting compound meeting UL 1309/CXS C22.2 No. 245 and IEEE 1580.
    - d. Armor: Basket weave bronze wire armor per IEEE 1580 and UL 1309/CSA C22.2 No. 245.
    - e. Sheath: Black, active grade, flame retardant, oil, abrasion, chemical and sunlight resistant thermosetting compound meeting UL 1309/CXS C22.2 No. 245 and IEEE 1580.,

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with the cable outer jacket and with the raceway involved.
- B. Tighten screws and terminal bolts using torque type wrenches, and/or drives, to tighten to the inch-pound requirements of the NEC and UL.
- C. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other

indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on centers.

### 3.2 CONDUCTOR - 600 V AND BELOW

- A. Provide conductor sizes as indicated on the drawings.
- B. Wire nuts may be used on solid conductors of 120 V and 277 V lighting and 120 V receptacle circuits only. Use King silicone filled pressure connectors or approved equal. Use crimp connectors on all stranded conductors. Place no more than one conductor in any single-barrel pressure connection.
- C. Soldered mechanical joints insulated with tape will not be acceptable.
- D. Vinyl plastic insulating tape for wire and cable splices and terminations shall be flame retardant, 7-mil thick minimum, rated for 90°C minimum meeting the requirements of UL 510.
- E. Provide terminals and connectors acceptable for the type of material used.
- F. Arrange wiring in cabinets, panels, and motor control centers neatly cut to proper length. Remove surplus wire, and braid and secure in an acceptable manner. Identify circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein.
- G. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate control and instrumentation wiring (except solid thermocouple leads) with insulated, locking-fork compression lugs, Thomas & Betts, Sta-Kon, or equal.
- H. For terminals designed to accept only bare wire compression terminations, use only stranded wire, and terminate only one wire per terminal. Tighten terminal screws with torque screwdriver to recommended torque values.
- I. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled, crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.
- J. Cap spare conductors and conductors not terminated with UL listed end caps.
- K. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- L. For conductors that will be connected by others, provide at least 6 feet spare conductor in freestanding panels, and at least 2 feet spare in other assemblies. Provide additional spare length in any particular assembly where it is obvious that more conductor length will be needed to reach the termination point.

### 3.3 CABLES

- A. Do not splice without permission of the ENGINEER. Locate splices, when permitted, only in

readily accessible cabinets or junction boxes using terminal strips.

- B. Where connections of cables installed under this section are to be made to instrumentation and controls, leave pigtails of adequate length for neat bundled type connections.
- C. Maintaining the integrity of shielding of instrumentation cables is essential to the operation of the control systems. Take special care in cable installation to ensure that grounds do not occur because of damage to the jacket over the shield.

#### 3.4 CABLE PLACEMENT:

- A. Immediately prior to the placement of each cable or cable group, inspect the raceway to determine that installation is complete and that the interior is clean and free of all materials detrimental to the cable or its placement. Group all cable assigned to a particular conduit and pulled simultaneously, using cable grips and acceptable lubricants.
- B. Provide adequately sized raceways to accommodate the number and size of cable as specified, and in compliance with Article 300 of the National Electric Code. If at any time during the progress of the work raceways appear inadequate to accommodate the assigned cable, notify the Owner at once and discontinue further work on the questionable raceway until advised by the Owner as to how to proceed.
- C. Carefully check all cable as to size and length before pulling into conduits. Remove and replace cable pulled into the wrong conduit or cut too short at no additional cost to the Owner. Do not pull cable removed from one conduit or duct into another conduit or duct without permission of the Owner.
- D. Fishing and pulling shall be performed with flexible round non-metallic tape, carbon dioxide, or forced air propelled polyethylene cord, nylon rope, or manila rope. No metallic cable or materials that may damage or scratch the inside surface shall be pulled into any conduit.
- E. Use woven wire cable grips to pull all low voltage single conductor cable, No. 2/0 and larger, and all low voltage multi-conductor cable. Use pulling loops to pull single conductor cable smaller than No. 2/0. When a cable grip is used for pulling, the arc of the cable covered by the grip plus 6 inches shall be cut off and discarded.
- F. Insert a reliable non-freezing type of swivel or swivel connection between the pulling ropes and the cable eye, or grip to prevent twisting under strain.
- G. Do not exceed the maximum pulling tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable, and the indicator shall be constantly watched. If any excessive strain develops, stop the pulling operation at once and determine and correct the difficulty.

#### 3.5 CONDUCTOR ARC AND FIREPROOFING TAPES

- A. Use arc and fireproofing tapes on 600 V single conductors and cables, except those rated Type TC, throughout their entire exposed length at splices in manholes, handholes, vaults, cable trays, and other indicated locations.
- B. Wrap together as a single cable conductors entering from each conduit.

- C. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

### 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.
  - 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**



**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Common ground bonding with lightning protection system.

**1.2 REFERENCES - NOT USED**

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**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. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inches in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inches thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inches thick.

- C. Grounding Bus: Rectangular bars of annealed copper, 1/4x2 inches in cross section, unless otherwise indicated; with insulators.

## 2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory 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, bolted 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 steel; 3/4 inch by 10 feet in diameter.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- 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. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors' level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
  - 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.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Signal and Communication Equipment: 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.
  - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4x2x12-inch grounding bus.
  - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- G. Metal 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.

### 3.4 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. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes and shall be at least 12 inches deep, with cover.
  - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting 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.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of area or item indicated.
1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
  2. Bury ground ring not less than 24 inches from building foundation.

### 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. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  3. Prepare dimensioned drawings locating each test well, ground rod and ground rod

assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven, their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- B. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10  $\Omega$ .
  - 2. Power and Lighting Equipment or System with Capacity 500-1,000 kVA: 5  $\Omega$ .
  - 3. Power and Lighting Equipment or System with Capacity More Than 1,000 kVA: 3  $\Omega$ .
  - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 5  $\Omega$ .
  - 5. Substations and Pad-Mounted Equipment: 5  $\Omega$ .
  - 6. Manhole Grounds: 10  $\Omega$ .
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTION**

**SECTION 26 05 29**  
**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

**1.2 REFERENCES**

- A. Comply with NFPA 70.
- B. Comply with MFMA-3.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**PART 2 - PRODUCTS**

**2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. General: Strut shall be 1-5/8 inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the drawings.
- C. Materials and Finish: Material and finish specifications for each strut type are as follows:
  - 1. Stainless Steel: All fittings and hardware shall be made of AISI Type 316 stainless steel.
- D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- E. Conduit and Cable Support Devices: AISI Type 316 stainless steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- F. 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.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars. Black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. 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. 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.
  - 2. Concrete Inserts: Stainless Steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: Stainless steel springhead type.
  - 6. Hanger Rods: Threaded stainless steel.

## 2.2 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

- A. Cast-In-Place Anchor Bolts:
  - 1. Unless otherwise shown on Drawings. F 593, AISI Type 316, Condition CW
- B. Anchor Bolt Sleeves:
  - 1. Plastic:
    - a. Single unit construction with corrugated sleeve.
    - b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
    - c. Material: High density polyethylene.
  - 2. Fabricated Steel: ASTM A 36.

## 2.3 CONCRETE AND MASONRY DRILLED ANCHORS

- A. Mechanical Expansion Anchors:
  - 1. Available Manufacturers: Any Manufacturer whose product complies with



specification will be acceptable.

2. Design Requirements: Anchor bolt and sleeve assembly shall have capability to sustain without failure, as determined by the Strength Design method when installed in cracked and uncracked concrete, in accordance with the International Building Code and as determined by testing in accordance with ASTM E 488 and AC-308.2.
  3. Material: AISI Type 304 and Type 316 stainless steel.
  4. Current evaluation and acceptance reports by ICC or other similar code organization and listed by UL and FM Global.
  5. Acceptable for use in potable water structures by NSF and local health organizations.
  6. Type:
    - a. ICC-ES Code Listed, Category 1, Cracked and Uncracked Concrete.
    - b. Self-drilling Anchors; snap-off or flush type, zinc-plated.
    - c. Non-drilling Anchors; flush type for use with zinc-plated or stainless-steel bolt, or stud type with projecting threaded stud.
  7. Size: As shown on Drawings and required for the concrete strength specified.
- B. Wedge Bolts:
1. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
  2. Material: Zinc plated, case hardened carbon steel.
  3. Current evaluation and acceptance reports by ICC or other similar code organization and listed by UL and FM Global.
  4. Type:
    - a. ICC-ES Code Listed, Category 1, Cracked and Uncracked Concrete.
    - b. Description: One-piece, heavy duty screw anchor with finished hex head suitable for cracked and uncracked concrete and grouted masonry.
  5. Size: As shown on Drawings and required for the concrete strength specified.
- C. Snake Anchors:
1. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
  2. Material: Zinc plated, case hardened carbon steel.
  3. Current evaluation and acceptance reports by ICC or other similar code organization and listed by UL and FM Global.
  4. Type:
    - a. ICC-ES Code Listed, Category 1, Cracked and Uncracked Concrete.
    - b. Description: Internally threaded, self-tapping screw anchor designed for performance in cracked and uncracked concrete and grouted masonry. Suitable base materials included normal-weight concrete, structural lightweight concrete, and concrete over metal deck.
  5. Size: As shown on Drawings and required for the concrete strength specified.
- D. Adhesive Anchors:
1. General: Adhesive anchoring system designed for bonding threaded anchor rod and

reinforcing bar hardware into drilled holes in concrete and solid masonry base materials.

2. Threaded rod:
    - a. Material: Unless otherwise specified:
      - 1) ASTM F 593 Stainless steel threaded rod, unless otherwise specified.
    - b. Diameter as shown on the Drawings or as required for the loads and conditions.
    - c. Length as required to provide minimum depth of embedment.
    - d. Clean and free of grease, oil, or other deleterious material.
    - e. For hollow-unit masonry, provide galvanized or stainless-steel wire cloth screen tube to fit threaded rod.
    - f. Anchor rods shall have rolled threads.
  3. Adhesive:
    - a. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
    - b. Two-component, high strength adhesive anchoring system designed to be used in adverse/thaw environments, with gray color mixing.
      - 1) ICC-ES Code Listed.
      - 2) Cure Temperature, Pot Life, and Workability: Compatible for the intended use and environmental conditions.
      - 3) Non-sag, with selected viscosity base on installation temperature and overhead application where applicable.
      - 4) ASTM Compliance:
        - a) Uncracked Concrete: Meets ASTM C881, Types I, II, IV, and V, Grade 3, Class A and B.
        - b) Uncracked and Cracked Concrete: Meets ASTM C881, Types I, II, IV, and V, Grade 3, Class B and C.
      - 5) Compliant with NSF/ANSI Standard 61 for potable water applications.
- E. Concrete Inserts:
1. For piping, grating and floor plate provide malleable iron inserts.
  2. Provide those recommended by the manufacturer for the required loading.
  3. Finish shall be black.
- F. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by ENGINEER.

## 2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Use stainless steel components unless otherwise shown on drawings.

- B. 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.
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit and cable tray as scheduled in NECA 1, where Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with support system, sized so capacity can be increased by at least 25% in the future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, conduit 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 the weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 6. To Light Steel: Sheet metal screws.
  - 7. 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.
- 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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

- B. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Materials
  - 1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
  - 2. Portland Cement: ASTM C 150, Type II or Type 1/II. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class C. Fly ash may be used for replacement of up to 15% of cement content by weight except for paving concrete.
  - 3. Normal-Weight Aggregate: ASTM C 33, graded, 1 inch nominal maximum aggregate size.
  - 4. Water: ASTM C 94; potable.
- C. Concrete Mixtures
  - 1. Comply with ACI 301 requirements for concrete mixtures.
  - 2. Provide concrete with the following mix design to result in concrete placed in the field of minimum compressive strength of 3,000 psi at 28 days based on test cylinders which are taken during concrete placement.

Unit	Measurement
Minimum Compressive Strength (7 day)	2,250 psi
Minimum Compressive Strength (28 day)	3,000 psi
Coarse Aggregate	ASTM C33, No. 467
Fine Aggregate	ASTM C33
Water/Cementitious Ratio (max.)	0.50 by weight
Air Entrainment	4-6 percent
Slump with Superplasticizer	7 inches to 9 inches
Slump without Superplasticizer	3 inches $\pm$ 1 inch
Minimum Cementitious Content	470 pounds per cubic yard

- D. Additive
  - 1. Red ferrous oxide concrete coloring pigment mixed at the rate of 1-1/2 lb. per sack of cement for electrical conduit.
- E. 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

**END OF SECTION**

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**SECTION 26 05 33**  
**RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

**1.2 REFERENCES - NOT USED**

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**PART 2 - PRODUCTS**

**2.1 ALUMINUM CONDUIT AND FITTINGS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that comply with UL 6A, "Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel" and is manufactured to ANSI C80.5. and manufactured of 6063 alloy in temper designation T-1.
- B. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

**2.2 PVC COATED ALUMINUM CONDUIT AND FITTINGS**

- A. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. PVC-Coated Aluminum Rigid Conduit:
  - 1. Alloy: Manufactured of 6063 alloy in temper designation T-1.
  - 2. Standards: UL 6A, "Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel" and is manufactured to ANSI C80.5.

3. Coating Thickness: 0.040 inch, minimum.
- C. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  1. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

### 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- F. Hinged-Cover Enclosures: NEMA 250, Type 4X, with continuous-hinge cover with fast-operating clamp-cover junction box clamp, Type 316 stainless steel, unless otherwise indicated.
  1. Metal Enclosures: Stainless Steel Type 316.

### 2.4 TERMINATION CABINETS & BOXES

- A. Termination cabinets shall be NEMA 4X, Type 316 stainless steel gasketed. Cabinets shall be configured as shown on the plans, and shall be of sufficient size to adequately contain all terminals, wire-duct, and cables as determined by the CONTRACTOR. Cabinets shall have fast-operating clamp-cover junction box clamp, Type 316 stainless steel.
- B. Acceptable manufacturers: Hoffman.

### 2.5 WIREWAY

- A. General:
  1. Suitable for lay-in conductors.
  2. Designed for continuous grounding.
  3. Covers:
    - a. Hinged or removable in accessible areas.
    - b. Non-removable when passing through partitions.
  4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
  5. Standards: UL 870, NEMA 250.
- B. Watertight (NEMA 4X rated) Wireway:
  1. 14 Gauge Type 304 or 316 stainless steel bodies and covers without knockouts and 10 Gauge stainless steel flanges.
  2. Cover: Fully gasketed and held in place with captive clamp type latches.



3. Flanges: Fully gasketed and bolted.

## 2.6 CONDUIT BODIES AND FITTINGS AND ACCESSORIES

### A. Fittings for Use with Aluminum Conduit:

1. General:
  - a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
  - a. Threaded stainless steel.
  - b. Gasketed or non-gasketed.
  - c. Grounding or non-grounding type.
3. Bushings:
  - a. Threaded, insulated metallic.
  - b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
  - a. Threaded straight type: Same material and finish as the conduit with which they are used on.
6. Unions: Threaded copper free cast aluminum.
7. Conduit bodies (ells and tees):
  - a. Body: Cast copper free aluminum with threaded hubs.
  - b. Standard and mogul size.
  - c. Cover:
    - 1) Clip-on type with stainless steel screws.
    - 2) Gasketed or non-gasketed cast copper free aluminum.
8. Conduit bodies (round):
  - a. Body: Cast copper free aluminum with threaded hubs.
  - b. Cover: Threaded screw on type, gasketed, cast copper free aluminum.
9. Sealing fittings:
  - a. Body: Cast copper free aluminum with threaded hubs.
  - b. Standard and mogul size.
  - c. With or without drain and breather.
  - d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
  - a. Liquid tight and arc resistant.
  - b. Electrically conductive so no bonding jumper is required.
  - c. Dry and wet areas:
    - 1) Bronze braided covering over flexible brass core.
    - 2) Bronze end fittings.
    - 3) Aluminum unions and nipples.
  - d. Corrosive areas:

- 1) Stainless steel braided covering over flexible stainless steel core.
  - 2) Stainless steel end fittings.
  - 3) Aluminum unions and nipples.
11. Expansion couplings:
    - a. 2 inch nominal straight-line conduit movement in either direction.
    - b. 4 inch nominal straight-line conduit movement in either direction.
    - c. Cast copper free aluminum with insulated bushing.
    - d. Gasketed for wet locations.
    - e. Internally or externally grounded.
  12. Expansion/deflection couplings:
    - a. 3/4 IN nominal straight-line conduit movement in either direction.
    - b. 30 degree nominal deflection from the normal in all directions.
    - c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    - d. Internally or externally grounded.
    - e. Watertight, raintight and concrete tight.
  13. Standards: UL 467, UL 514B, UL 886.
- B. Fittings for Use with PVC-Aluminum:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with Aluminum Conduit" and coated as defined under paragraph "PVC Coated Aluminum Conduit"

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Aluminum rigid conduit.
  2. Concealed Conduit, Above ground: Aluminum rigid conduit.
  3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
  4. Under concrete slab: RNC, Type EPC-40-PVC, concrete encased.
  5. Concealed in Concrete: RNC, Type EPC-40-PVC.
  6. Chemical areas: PVC-coated aluminum rigid conduit .
  7. Installed in wet-wells: PVC-coated aluminum rigid conduit.
  8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): PVC Coated Light-tight Flexi able Metal Conduit.
  9. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X, stainless steel.
- B. Indoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Aluminum rigid conduit.
  2. Concealed in Ceilings and Interior Walls and Partitions: Aluminum rigid conduit.
  3. Concealed in Masonry or CMU walls: RNC, Type EPC-80-PVC..

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): PVC Coated Light-tight Flexible Metal Conduit.
  5. Damp or Wet Locations: Aluminum rigid conduit.
  6. Chemical areas: PVC-coated aluminum rigid conduit.
  7. Boxes and Enclosures: NEMA 250, Type 4, except use NEMA 250, Type 4X, stainless steel in damp, wet, or chemical locations.
- C. Minimum Raceway Size: 3/4-inch trade size. Minimum size for underground conduit shall be 1-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. PVC Externally Coated, Aluminum Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Do not install aluminum conduits in contact with concrete.

### 3.2 CONDUIT BODIES AND FITTINGS AND ACCESSORIES

- A. Conduit bodies and fittings shall not reduce the conduit fill area for the size of conduit to which they are installed. The next size of conduit body or fitting shall be installed if required.
- B. Conduit Seals:
1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
- C. Install Expansion Fittings:
1. Where conduits are exposed to the sun and conduit run is greater than 200 feet.
  2. Elsewhere as identified on the Drawings.
- D. Install Expansion/Deflection Fittings:
1. Where conduits enter a structure.
    - a. Except electrical manholes and handholes.
    - b. Except where the ductbank is tied to the structure with rebar.
  2. Where conduits span structural expansion joints.
  3. Elsewhere as identified on the Drawings.
- E. Threaded connections shall be made wrench-tight.
- F. Conduit joints shall be watertight:
1. Where subjected to possible submersion.
  2. In areas classified as wet.
  3. Underground.
- G. Terminate Conduits:
1. In metallic outlet boxes:
    - a. Conduit hub and locknut.
    - b. Insulated bushing and two (2) locknuts.
    - c. Use grounding type locknut or bushing when required by NFPA 70.

2. In NEMA 12 rated enclosures:
  - a. Watertight, insulated and gasketed hub and locknut.
  - b. Use grounding type locknut or bushing when required by NFPA 70.
3. In NEMA 4X rated enclosures:
  - a. Watertight, insulated and gasketed hub and locknut.
4. In NEMA 7 rated enclosures:
  - a. Into an integral threaded hub.
5. When stubbed up through the floor into floor mount equipment:
  - a. With an insulated grounding bushing on metallic conduits.
  - b. With end bells on non-metallic conduits.

### 3.3 OUTLET, PULL AND JUNCTION BOX INSTALLATION

#### A. General:

1. Install products in accordance with manufacturer's instructions.
2. See the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

#### B. Outlet Boxes:

1. Permitted uses of metallic outlet boxes:
  - a. Housing of wiring devices:
    - 1) Recessed in all stud framed walls and ceilings.
    - 2) Recessed in poured concrete, concrete block, and brick walls of architecturally finished areas and exterior building walls.
  - b. Pull or junction box:
    - 1) Above gypsum wall board or acoustical tile ceilings.
    - 2) Above 10 feet in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
  - a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet corrosive, and hazardous areas.
  - b. Pull and junction box surface mounted in non-architecturally finished dry, wet, and corrosive areas.
3. Permitted uses of non-metallic outlet boxes:
  - a. Housing of wiring devices surface mounted in non-architecturally finished corrosive areas.
  - b. Pull and junction box surface mounted in non-architecturally finished corrosive areas.
4. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Section 26 27 26 - Wiring Devices.
5. Set device outlet boxes plumb and vertical to the floor.
6. Outlet boxes recessed in walls:

- a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
  - b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
- 7. Place barriers between switches in boxes with 277 V switches on opposite phases.
- 8. Back-to-back are not permitted.
- 9. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.
- C. Pull and Junction Boxes:
  - 1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
    - a. Make covers of boxes accessible.
  - 2. Permitted uses of NEMA 4X metallic enclosure:
    - a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
  - 3. Permitted uses of NEMA 4X non-metallic enclosure:
    - a. Pull or junction box surfaced mounted in areas designated as wet and/or highly corrosive.
  - 4. Permitted uses of NEMA 7 enclosure:
    - a. Pull or junction box surface mounted in areas designated as Class I hazardous.
      - 1) Provide PVC coating in corrosive areas when PVC coated conduit is used.
  - 5. Permitted uses of NEMA 12 enclosure:
    - a. Pull or junction box surface mounted in areas designated as dry.

### 3.4 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- F. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
- G. Raceways Embedded or under slabs in Slabs:
  - 1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Provide Aluminum Rigid PVC-Coated conduit bends for PVC conduits 2-inch and larger.
  4. At the transition from PVC to rigid aluminum conduit, extend PVC Coated rigid aluminum conduit a minimum of 6 inches into the concrete.
- H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
  - I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb. tensile strength. Leave at least 12 inches of slack at each end of pull wire.
  - J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings where indicated on drawings.
  - K. Expansion-deflection Fittings for Rigid Aluminum Conduit and PVC-Coated Conduit: Install in each run of aboveground conduit crossing structural expansion joints and on exposed conduit runs of more than 100 feet or where necessary. Provide bonding jumpers across fittings.
  - L. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - M. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.
  - N. Set metal floor boxes level and flush with finished floor surface.

### 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping in accordance with applicable regulations
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
  2. For sleeve cross-section rectangle perimeter equal to, or greater than 50 inches and 1 or more sides equal to or greater than 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

### 3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

### 3.8 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

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**SECTION 26 05 43**  
**UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs.
  - 2. Handholes and boxes.
  - 3. Manholes.

**1.2 REFERENCES**

- A. RNC: Rigid nonmetallic conduit.

**1.3 ADMINISTRATIVE REQUIREMENTS**

**A. COORDINATION**

- 1. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- 2. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by ENGINEER.

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**PART 2 - PRODUCTS**

**2.1 PVC EXTERNALLY COATED RIGID GALVANIZED CONDUIT**

- A. Subject to compliance with requirements, manufacturers offering products that offer PVC Externally Coated Rigid Galvanized Conduit ETL-PVC-001.
- B. PVC Externally-Coated Rigid Galvanized Conduit:
  - 1. All PVC coated rigid galvanized conduit shall be ETL-PVC-001 Certified.
  - 2. Shall be ANSI C80.1 hot-dipped galvanized rigid conduit with an external 0.040" minimum PVC protective coating per NEMA Standard RN1. Both ends of conduit shall be threaded and thread protectors shall be factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized with a 0.055" minimum PVC coating to match the conduit.
- C. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

## 2.2 PVC CONDUIT

- A. RNC: Conforming to 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.

## 2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- 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:
  - 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. 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 spacing indicated while supporting ducts during concreting or backfilling.

## 2.4 DETECTABLE WARNING TAPE

- A. Description: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick,

continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep. Tape shall be red in color for electrical, orange in color for communication. Printed legend shall indicate type of underground line

## 2.5 PRECAST MANHOLES

- A. Available Manufacturers: Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. Comply with ASTM C 858, with AASHTO H-17, H-20 structural design load rating, and with interlocking mating sections, complete with accessories, hardware, and features.
  - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
    - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.6 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Available Manufacturers: Any Manufacturer whose product complies with specification will be acceptable.
- B. Manhole Access Covers, and Chimney Components: Comply with structural design loading specified for manhole.
- C. Access Covers:
  - a. Designed for incidental H-20 Wheel Loading
  - b. Diamond Plate Surface, labeled "Electric"
  - c. Torsion Bar Assist opening with safety latch to prevent accidental closing.
  - d. Size 36x36 inches
  - e. Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  - f. Similar to Jensen Precast CAA-3636
  - g. Configuration: Imbedded into top ring cover
- 2. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of the manhole.

- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1x4-inch bolt.
  - 1. Working Load Embedded in 6-Inch, 4,000-psi Concrete: 13,000 lb ft minimum tension.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
  - 1. Ultimate Yield Strength: 40,000 lb ft shear and 60,000 lb ft tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2x2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
  - 1. Tested Ultimate Pullout Strength: 12,000 lb ft minimum.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5,300 lb ft rated pullout strength, and minimum 6,800-lb ft rated shear strength.
- I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
  - 1. Stanchions: Nominal 36 inches high x4 inches wide, with a minimum of 9 holes for arm attachment.
  - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450 lb. minimum capacity to 20 inches with 250 lb. minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35°F. Capable of withstanding temperature of 300°F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- K. Fixed Manhole Ladders: Arranged for attachment to roof of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- L. Cover Hooks: Heavy duty, designed for lifts 60 lb ft and greater. Two required.

## 2.7 UNDERGROUND DUCTS STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

## 2.8 UNDERGROUND DUCTS CONCRETE

A. Materials

1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
2. Portland Cement: ASTM C 150, Type II or Type 1/II. Supplement with the following:
  - a. Fly Ash: ASTM C 618, Class C. Fly ash may be used for replacement of up to 15% of cement content by weight except for paving concrete.
3. Normal-Weight Aggregate: ASTM C 33, graded, 1 inch nominal maximum aggregate size.
4. Water: ASTM C 94; potable.

B. Concrete Mixtures

1. Comply with ACI 301 requirements for concrete mixtures.
2. Provide concrete with the following mix design to result in concrete placed in the field of minimum compressive strength of 3,000 psi at 28 days based on test cylinders which are taken during concrete placement.

Unit	Measurement
Minimum Compressive Strength (7 day)	2,250 psi
Minimum Compressive Strength (28 day)	3,000 psi
Coarse Aggregate	ASTM C33, No. 467
Fine Aggregate	ASTM C33
Water/Cementitious Ratio (max.)	0.50 by weight
Air Entrainment	4-6 percent
Slump with Superplasticizer	7 inches to 9 inches
Slump without Superplasticizer	3 inches ± 1 inch
Minimum Cementitious Content	470 pounds per cubic yard

C. Additive

1. Red ferrous oxide concrete coloring pigment mixed at the rate of 1-1/2 lb. per sack of cement for electrical conduit.

2.9 GROUNDING

- A. Bare Copper Conductors: Shall be tinned, stranded Conductors complying with ASTM B 8 and Tinned Conductors: ASTM B 33.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- C. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in length.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
  1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

### PART 3 - EXECUTION

#### 3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts shall be RNC, NEMA Type EPC-40-PVC, in reinforced, concrete-encased duct bank, unless otherwise indicated.

#### 3.2 EARTHWORK

##### A. Excavation

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation for trenches.
2. During inclement weather and where site conditions warrant, take precautions to prevent surface-water run-off from entering the excavation. Remove and dispose of water entering trench, as necessary grade trench bottom and compact subgrade. Do not place bedding, lay pipe, conduits, cables, or duct banks in water. Provide continuous control of water until trench backfill is complete.
3. Excavate to lines, grades, depths, and dimensions shown and as necessary to accomplish Work. Allow for excavation support and protection materials, working space, bedding course, topsoil, and related materials.
4. Excavate trenches to uniform widths to provide required clearance of each side of conduit. Trench walls shall be vertical to elevation equal to 12 inches above top of conduits or duct banks.
5. Proceed with caution in areas of existing utilities exposing them by hand excavation or other means acceptable to utility owner. Protect, support, and maintain existing utilities.
6. Avoid disturbing soil within branch spread of trees designated for protection. If it is necessary to excavate through roots, perform work by hand and cut roots with a sharp axe.

##### B. Preparation of Trench Bottom

1. Subgrade: Grade with hand tools, remove loose and disturbed materials, and trim off high areas left by excavating bucket teeth. Allow space for bedding material as required.
2. Soft Subgrade: Remove any soft subgrade, replacing with trench stabilizing material.

#### 3.3 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5 degree angle couplings for small changes in direction. Use manufactured long sweep bends, 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 Manholes and Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
  - 2. Grout end bells into structure walls from both sides to provide watertight entrances.
  - 3. Tie duct bank reinforcing steel into dowels at manhole walls.
- E. Wall Penetrations: Make a transition from underground duct to PVC coated-aluminum conduit at least 10 feet outside the 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 walls in accordance with Division 26 Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- 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 hydrostatic pressure.
- G. Pulling Cord: Install 100 lb ft 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 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches 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 manholes or other 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.
  - 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 as shown on Drawings.
  - 5. Forms: Use walls of trench to form sidewalls 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, 2 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 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  8. Stub-Ups: Use PVC coated-rigid galvanized steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    - a. Couple PVC coated- rigid galvanized 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 PVC coated- rigid galvanized steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
- I. Underground-Line Warning Tape
1. 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.

### 3.4 BACKFILL

#### A. General:

1. Process excavated material to meet specified soil fill requirements. Adjust moisture as necessary to obtain specified compaction. Place and compact backfill in 8-inch loose lifts.
2. Do not allow backfill to free-fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after 2 feet of backfill has been placed.
3. Do not use power-driven impact type compactors until at least 4 feet of backfill is placed over top of pipe.
4. Backfill to grade with allowances for topsoil, crushed rock surfacing, pavements, or other work.
5. Settling backfill by jetting or flooding will only be permitted as shown on the Drawings or when approved by Engineer in writing. Trenches improperly backfilled and compacted, or where settlement occurs, shall be excavated to depth required, backfilled, compacted, and surface restored to required grade.

#### B. Density Control

1. Areas Subjected to or Influenced by Vehicular Traffic. Unless otherwise indicated on the Drawings, compact backfill to a minimum 100% of maximum density as determined in accordance with ASTM D698, with required moisture content within minus 2 to plus 4 of optimum.
2. Areas Not Subjected to or Influenced by Vehicular Traffic. Unless otherwise indicated on the Drawings, compact backfill to a minimum 95% of maximum density as determined in accordance with ASTM D698, with required moisture content within minus 2 to plus 4 of optimum.

### 3.5 UNDERGROUND CONDUIT MARKERS

- A. Mark underground duct banks 24x24x4 inch concrete marker with etched lettering and



arrows indicating the duct bank route.

- B. Install markers at point of origin, at point of termination, at bends, and at 100-foot intervals, even if not shown on plans.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Elevations:
  - 1. Manhole Roof: Install with rooftop at least 6 inches above finished grade. In paved areas and trafficways, set manhole roofs 1 inch above finished. Set other manhole frames 1 inch above finished grade.
- B. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- C. Hardware: 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.
- D. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- E. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- F. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

### 3.7 GROUNDING

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum. Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- 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. Grounding Underground Distribution System Components
  - 1. Comply with IEEE C2 grounding requirements.
  - 2. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
  - 3. Grounding Connections to Manhole Components: Bond exposed-metal parts such as

inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors' level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

E. INSTALLATION

1. 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.
2. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

3.8 FIELD QUALITY CONTROL

A. Perform the following 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% fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 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.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

**END OF SECTION**

**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
- B. Identification for raceway.
- C. Identification for conductors and communication and control cable.
- D. Warning labels and signs.
- E. Instruction signs.
- F. Equipment identification labels.
- G. Miscellaneous identification products.

**1.2 REFERENCES - NOT USED**

**1.3 ADMINISTRATIVE REQUIREMENTS**

**A. COORDINATION**

- 1. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, Manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- 2. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- 3. Coordinate installation of identifying devices with location of access panels and doors.
- 4. Install identifying devices before installing acoustical ceilings and similar concealment.

**1.4 SUBMITTALS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.7 SITE CONDITIONS**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

**1.8 WARRANTY**

- A. Refer to Section 26 00 00 - Electrical General Provisions.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

#### A. Nameplates:

1. Provide a nameplate for each piece of mechanical equipment, process equipment, valve, pump, mixer, feeder, fan, air-handling unit, motor, switch, receptacle, controller, instrument transducer, instrument power supply, solenoid, motor control center, starter, panelboard, switchboard, individually mounted or plug-in type circuit protector or motor controller, disconnect switch, bus duct tap switch, time switch, relay and for any other control device or major item of electrical equipment, either located in the field or within panels.
2. Provide all nameplates of identical style, color, and material throughout the facility.
3. Device nameplates information:
  - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
  - b. Device tag and loop number ID (#) (e.g. EDV-#).
  - c. Circuit ID (e.g. LPA-11).
  - d. Area served (e.g. Lighting Chemical Building).

#### B. Wire numbers:

1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
  - a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
  - b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
  - c. Internal panel wires on a common terminal shall have the same wire number.
2. Provide the following wiring numbering schemes throughout the project for field wires between programmable logic controllers, (PLC), vendor control panels, (CP), motor control centers, (MCC), field starters, field instruments, etc.
  - a. Where:
    - 1) ORIGIN LOC. = Designation for originating panel or device
    - 2) ORIGIN TERM. = Terminal designation at originating panel or device
    - 3) DEST. LOC. = Designation for destination panel or device
    - 4) DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel
  - b. Identify equipment and field instruments as the origin.
  - c. PLCs are always identified as the destination.
  - d. Location is the panel designation for CP, LCP, or PLC. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments, and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
  - e. Terminal designation is the actual number on the terminal block where the

- conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
- f. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
  - g. Terminal designations at PLCs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):
    - 1) Discrete Point: W:X:Y/Z or Analog Point: W:X:Y.Z
      - a) Where:
        - i. W = I for input, O for output
        - ii. X = PLC number (1, 2, 3...)
        - iii. Y = Slot number (01, 02, 03...)
        - iv. Z = Terminal number (00, 01, 02...) for a discrete point or a word number for an analog point (1, 2, 3...)
    - h. Terminal designations at PLCs where the conductor does not connect to a PLC input point or output point shall be the terminal number with a "C" prefix (e.g. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g. C0010A).
3. Case 1: Vendor control panel (CP) to Programmable Logic Controller (PLC):
- a. Field wire number/label: A-B/C-D
    - 1) A = Vendor control panel number without hyphen (CP#)
    - 2) B = Terminal number within CP (manufacturer's or vendor's standard terminal number)
    - 3) C = Programmable Logic Controller number without hyphen (PLC#)
    - 4) D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
    - 5) Examples:
      - a) CP#-10/PLC#-I:1:01/01
      - b) CP#-10/PLC#-O:1:10/07
      - c) CP#-10/PLC#-C0100
4. Case 2: Field instrument to Programmable Logic Controller (PLC):
- a. Field wire number/label: E-F/C-D
    - 1) C = Programmable Logic Controller number without hyphen (PLC#)
    - 2) D = Either the PLC address if the field terminal is connected directly to a PLC
    - 3) Input or Output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
    - 4) E = Field mounted instrument tag and loop numbers without hyphen

(EDV#)

- 5) F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma
  - 6) Examples:
    - a) TIT#-2,3/PLC#-I:1:01.1
    - b) TSH#-1/PLC#-I:2:01/00
5. Case 3: Motor control center (MCC) to Programmable Logic Controller (PLC):
- a. Field wire number/label: G-B/C-D
    - 1) B = Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)
    - 2) C = Programmable Logic Controller without hyphen (PLC#)
    - 3) D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
    - 4) G = Actual starter designation in the motor control center without hyphen (MMS#)
    - 5) Examples:
      - a) MMS#-10/PLC#-I:1:01/01
      - b) MMS#-10/PLC#-O:1:10/07
      - c) MMS#-10/PLC#-C0100
6. Case 4: Motor control center (MCC) to vendor control panel (CP):
- a. Field wire number/label: G-B/A-B
  - b. A = Vendor control panel number without hyphen (CP#)
  - c. B = Terminal number within motor control center or vendor control panel
  - d. (manufacturer's or vendors standard terminal number)
  - e. G = Actual starter designation in the motor control center without hyphen (MMS#)
  - f. Example:
    - 1) MMS#-X2/CP#-10
7. Case 5: Motor leads to a motor control center (MCC):
- a. Field wire number/label: H-I/G-B
  - b. B = Terminal number within motor control center (manufacturer's standard terminal number)
  - c. G = Actual starter designation in the motor control center without hyphen (MMS#)
  - d. H = Equipment tag and loop number without hyphen (PMP#)
  - e. I = Motor manufacturer's standard motor lead identification (e.g. T1, T2, T3, etc.)
  - f. Example:
    - 1) PMP#-T3/MMS#-T3
8. Case 6: Remote or separately mounted starter or variable frequency drive (VFD) to

Programmable Logic Controller (PLC):

- a. Field wire number/label: J-B/C-D
  - b. B = Terminal number within starter or variable frequency drive
  - c. (manufacturer's standard terminal number)
  - d. C = Programmable Logic Controller number without hyphen (CP#)
  - e. D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
  - f. J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)
  - g. Examples:
    - 1) MMS#-10/PLC#-I:1:01/01
    - 2) MMS#-10/PLC#-O:2:10/07
    - 3) MMS#-10/PLC#-C0010
9. Identify all spare conductors as required for other field wires with an "S" prefix:  
Example: S MMS#-10/PLC#-C011

## 2.2 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 and cable size.
- B. Color for Printed Legend:
  1. Power Circuits: Black letters on an orange field.
  2. Legend: Indicate system or service and voltage, if applicable.
- 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. Snap-Around Labels: Slit, pretension, flexible, preprinted, color-coded acrylic sleeves, 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: Slit, pretension, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

## 2.3 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. All markings to labels, schedules, tags on nameplates shall be machine printed only. Hand printing is prohibited. Circuits shall be tagged at terminations (both ends), in pull boxes, cabinets and enclosures as follows;
  1. Tags relying on adhesives or taps-on markers are not acceptable.
  2. Hand written tags are not acceptable.
  3. Provide conductor tags for conductors No. 10 AWG and below with legible permanent

sleeve of yellow or white PVC with machine printed black marking, Raychem TMS sleeves or approved equal.

4. Provide tags for cables and for conductors No. 8 AWG and larger consisting of permanent nylon marker plates with legible designations hat tamped on the plate. Attach these marker plates to conductors and calves with stainless steel wire wraps. Tags shall be Raychem TMS-CM cable markers or approved equal.
  5. Tags shall be imprinted with panelboard and panelboard position number (e.g. LA3-23) for conductors fed from panelboards. Other conductors shall have tags imprinted with the MCC which feeds the conductors (e.g. MCC 1).
  6. Switch-legs shall the designation descried above their tags, plus an "S" suffix. Travelers shall have the designation described able on their taps, plus a "T" suffix.
  7. Where more than one neutral is present with a group of conductors, a tag shall be applied to each neutral indicating which phase conductors are served by each neutral (e.g. HA-2, 4, 6).
- B. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1-2 inches wide.

#### 2.4 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: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7x10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10x14 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."

#### 2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch thick for signs up to 20 square inches and 1/8-inch thick for larger sizes.
  1. Engraved legend with Insert colors.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.



## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength: 50 lb., minimum.
  - 3. Temperature Range: Minus 40 to plus 185°F.
  - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## 2.8 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  - 1. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep. Tape shall be red in color for electrical, orange in color for communication. Printed legend shall indicate type of underground line
- B. Color and Printing:
  - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
  - 2. Inscriptions for Red-Colored Tapes: "ELECTRIC LINES"

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH

- VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with orange self-adhesive vinyl label.
  - D. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
  - E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use metal tags. Identify each ungrounded conductor according to source and circuit number.
  - F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
  - G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 Operation and Maintenance Manual.
  - H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
    - 1. 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.
    - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
  - J. Instruction Signs:
    - 1. Operating Instructions: 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.
    - 2. Emergency Operating Instructions: 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.
  - K. Equipment Identification Labels: On each unit of equipment, install unique designation label

that is consistent with wiring diagrams, schedules, and 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.

L. Labeling Instructions:

1. Indoor Equipment: 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 2 lines of text are required, use labels 2 inches high.
2. Outdoor Equipment: Stenciled legend 4 inches high.
3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4. Equipment to Be Labeled:
  - a. Panelboards, electrical cabinets, and enclosures.
  - b. Access doors and panels for concealed electrical items.
  - c. Electrical switchgear and switchboards.
  - d. Transformers.
  - e. Electrical substations.
  - f. Emergency system boxes and enclosures.
  - g. Motor-control centers.
  - h. Disconnect switches.
  - i. Enclosed circuit breakers.
  - j. Motor starters.
  - k. Push-button stations.
  - l. Power transfer equipment.
  - m. Contactors.
  - n. Remote-controlled switches, dimmer modules, and control devices.
  - o. Battery inverter units.
  - p. Battery racks.
  - q. Power-generating units.
  - r. Voice and data cable terminal equipment.
  - s. Master clock and program equipment.
  - t. Intercommunication and call system master and staff stations.
  - u. Television/audio components, racks, and controls.
  - v. Fire-alarm control panel and annunciator.
  - w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
  - x. Monitoring and control equipment.
  - y. Uninterruptible power supply equipment.
  - z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

### 3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color 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.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
    - 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.
  - 2. 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 2 turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

**END OF SECTION**

**SECTION 26 05 73**  
**POWER SYSTEM STUDIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. General:**

1. The Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for [switchgear,] switchboards, [motor control centers,] distribution panels, panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.
2. The Electrical Contractor shall provide the Engineer with a Power System Short Circuit Analysis, Protective Device Coordination Study, Emergency Power System Selective Coordination Study and Arc Flash and Electrical Hazard Study. These analysis's and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company and emergency power source(s) to the secondary buses of each panelboard as described hereafter.
3. Shall be prepared by and certified with a registration seal and signature of a Registered Professional Engineer. The Engineer shall be qualified by experience in preparation of studies having similar requirements and of similar magnitude to that specified in this section of the Specifications.
4. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes, total source plus all motor contribution, is less than 10,000 amperes for 208/240 volts and 14,000 amperes for 480 volts. It is the intent of these Specifications to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at 208 volts and 14,000 amperes at 480 volts. The short circuit analysis shall compare interrupting rating of all installed electrical protective devices connected to each bus included in the study with that of the available fault current at the load terminals of each protective device. Appropriate recommendations shall be made for corrective action in the conclusions of the report where the interrupting rating of electrical equipment is exceeded by the available fault current.
5. The Protective Device Coordination Study shall start at the electric service and include all electrical distribution equipment protective devices with adjustable trip units, relay settings or options for fuse types. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the first non-adjustable overcurrent device or devices downstream of all protective devices with an adjustable trip unit, relay settings or options for fuse types. The protective device study shall include a separate analysis for phase and ground protection.
6. The Emergency Power System Selective Coordination Study shall comply with all applicable NEC requirements and shall start at the electric service and emergency power source(s) and include all electrical distribution equipment protective devices to

and including the final branch circuit protective devices serving applicable emergency loads. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the final branch circuit protective devices serving applicable emergency loads. The protective device study shall include a separate analysis for phase and ground protection.

7. The Arc Flash and Electrical Hazard Study comply with applicable NEC and OSHA requirements and shall include calculating the Arc Flash and establishing the Electrical Hazard rating for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
  8. The Contractor shall obtain all lengths of cable from the electrical drawings and, where not shown the entire length of the run, from Contractor estimated lengths to longest possible lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturer's and/or suppliers.
- B. Short Circuit Analysis: The Analysis shall include the following:
1. A schematic one-line drawing of the entire electrical system included in the study, from the power company system including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified using project assigned identification labels. Each motor 10 hp and larger shall be shown and identified. Each bus shall be assigned an identification number.
  2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on an assumed bolted 3 phase short circuit.
  3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated for assumed bolted 3 phase short circuits.
    - a. Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.
    - b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
    - c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both The Power Company source and all motor contributions.
  4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.
  5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including The Power Company source impedance plus any primary motor contribution.
  6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent

parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.

7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The Power Company plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.
  8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 hp and larger. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.
  9. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer. For this evaluation, circuit breakers shall all be fully rated.
  10. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.
- C. Protective Device Coordination Study: The Study shall include the following:
1. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
  2. The Power Company's relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.
  3. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.
  4. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.
  5. The coordination plots shall include significant motor starting characteristics and large motor protective devices.
  6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short circuits as recommended by ICEA shall be indicated.
  7. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible.

The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.

8. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with [service continuity] [system protection] considered more important than system protection/service continuity. The time-current coordination analysis shall be performed with the aid appropriate software.
  9. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
  10. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.
  11. When main breaker is provided with setback to reduce the arc fault level both settings shall be included in the study.
  12. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.
- D. Emergency Power System Selective Coordination Study: The Study shall include the following:
1. Confirmation of selective coordination of all overcurrent devices associated with supplying utility and generator/UPS to emergency loads in accordance with all applicable requirements of NEC Article 100 and Paragraphs 700.27 and 701.18. Study shall be based on coordination to [0.1] [0.01] seconds. Study shall be based on the actual electrical equipment and overcurrent protective devices being submitted for the project.
  2. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
  3. Circuit breakers shall indicate manufacturer and type and have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current.
  4. Fuses shall have fuse manufacturer and type indicated. Fuse curves shall be identified as either total clearing time or damage time as applicable.
  5. High voltage relays shall indicate manufacturer and type and have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
  6. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.



7. Confirmation that the proposed overcurrent protection devices, set or selected as recommended, will provide the specified selective coordination. Should the overcurrent devices proposed for the project not be capable of providing the specified selective coordination, the report shall include recommendations for overcurrent protective device changes required to provide the specified coordination and calculations, plots, recommended settings as specified herein for the recommended overcurrent device changes to provide the specified selective coordination.
  8. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.
- E. Arc Flash & Electrical Hazard Analysis: The Analysis shall include the following:
1. The Arc-Flash & Electrical Hazard Analysis (AFEHA) shall be performed in accordance with the requirements of NFPA 70 Section 110.16, NESC ANSI C2-2007 Section 410.A.3, IEEE Std. 1584 and OSHA 29 CFR 1910.132(d) and 1910.335.
  2. The AFEHA shall:
    - a. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information.
    - b. Calculate the Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm<sup>2</sup>) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
    - c. Identify the Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
    - d. Identify the current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
    - e. Establish the Flash Protection Boundary (approach limit distance) as required by NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
    - f. Provide equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.
    - g. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements
    - h. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

## 1.2 REFERENCES - NOT USED

## 1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED

#### 1.4 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Four copies of the Short-Circuit Analysis including, but not limited to:
    - a. A printout of input data, calculated results and an explanation of how to interpret the data.
    - b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
    - c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.
    - d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where specified equipment short-circuit ratings are less or greater than required at the point of application.
    - e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.
  2. Four copies of the Protective Device Coordination Study including, but not limited to:
    - a. Time-current characteristic curve drawings on log-log printouts which illustrate:
      - 1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.
      - 2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.
      - 3) The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
    - b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.
    - c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.
  3. Four copies of the Emergency Power System Selective Coordination Study including, but not limited to:
    - a. Time-current characteristic curve drawings on log-log printouts which illustrate:
      - 1) Compliance of the provided overcurrent protective devices with the specified selective coordination requirements.
      - 2) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.
    - b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.
    - c. An analysis of the results in which any inadequacies related to the specified selective coordination shall be called to the attention of the Engineer with

recommendations for improved coordination.

4. Four copies of the arc-flash & electrical hazard analysis including, but not limited to:
  - a. Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm<sup>2</sup>) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
  - b. Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
  - c. Current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
  - d. The Flash Protection Boundary (approach limit distance) as required by NFPA 70 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
  - e. Equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.
  - f. Recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements
5. Cut sheets and submittal information on the Arc Flash warning labels being provided.

#### 1.5 QUALITY ASSURANCE

- A. The short circuit analysis/coordination study shall be performed by the Engineering Department of the electrical equipment supplied for the project or by a qualified engineering consultant approved in writing in advance by the Engineer.

#### 1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

#### 1.7 SITE CONDITIONS - NOT USED

#### 1.8 WARRANTY - NOT USED

#### 1.9 STUDY AND ANALYSIS SEQUENCE:

- A. All studies and analysis specified herein shall be completed and submitted with electrical distribution equipment submittals to allow the Engineer to review submitted electrical distribution equipment for interrupting rating, coordination and arc flash related coordination.

### PART 2 - PRODUCTS

#### 2.1 ARC FLASH WARNING LABELS:

- A. Labels: Seton Write-On Arc Flash Warning Labels or an approved equal label with NEC and OSHA required warning information and with Arc Flash Hazard Category, minimum Personal

Protection Equipment (PPE) required and Minimum Arc Rating (cal/cm<sup>2</sup>) clearly indicated.

### PART 3 - EXECUTION

#### 3.1 PROTECTIVE DEVICE SELECTION AND SETTING:

- A. Settings and Selection: Prior to project Substantial Completion, the Contractor shall set all relays, overcurrent devices and ground fault protection devices and confirm selection of fuse overcurrent devices as follows:
  - 1. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this section.
  - 2. Circuit Breakers: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this section.
  - 3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this section.
  - 4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified in this section.
- B. Certification: Prior to project Substantial Completion, the Contractor shall submit 4 signed copies of a document certifying that the Contractor has completed the settings and selection scope specified in Paragraph 3.1 A. to the Engineer.

#### 3.2 ARC FLASH WARNING LABELS:

- A. Installation: Arc Flash warning labels shall be securely affixed to each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch in a readily visible location in accordance with NEC and OSHA requirements. The actual calculated Minimum Arc Rating (cal/cm<sup>2</sup>) for that individual piece of equipment along with the associated Arc Flash Hazard Category and minimum Personal Protection Equipment (PPE) required shall be clearly indicated on each warning label.

**END OF SECTION**

**SECTION 26 24 16.11**  
**PANELBOARDS – LIGHTING AND APPLIANCE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for lighting and appliance panelboards (also identified as panelboard, LP) as required for the complete performance of the Work, as shown on the Drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.
- B. Related Sections: Related sections include, but shall not be limited to, the following:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.

**1.2 REFERENCES**

- A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
  - 1. American Society of Civil Engineers (ASCE):
    - a. ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
  - 2. California Office of Statewide Health Planning and Development (OSHPD)
  - 3. Canadian Standards Association (CSA):
    - a. CSA C22.2 No. 5, "Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures."
    - b. CSA C22.2 No. 29, "Panelboards and Enclosed Panelboards."
  - 4. USA Federal Specifications (FS):
    - a. FS W-C-375, "Circuit Breakers, Molded Case, Branch Circuit and Service."
    - b. FS W-P-115, "Panel, Power Distribution."
  - 5. International Code Council (ICC):
    - a. ICC IBC, "International Building Code."
    - b. ICC IBC Section 1621, "Architectural, Mechanical, and Electrical Component Seismic Design Requirements."
    - c. ICC ES AC156, "International Code Council Evaluation Services Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems"
  - 6. National Electrical Manufacturers Association (NEMA):
    - a. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."

- b. NEMA PB 1, "Panelboards."
- c. NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
- 7. National Fire Protection Agency (NFPA)
  - a. NFPA 70, "National Electrical Code," hereinafter referred to as NEC.
  - b. NFPA 5000, "Building Construction and Safety Code."
- 8. Underwriter Laboratories (UL):
  - a. UL 50, "Enclosures for Electrical Equipment, Non-Environmental Considerations."
  - b. UL50E, "Enclosures for Electrical Equipment, Environmental Considerations."
  - c. UL 67, "Standard for Panelboards."
  - d. UL 489, "Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures."
- 9. International Electrotechnical Commission (IEC)
  - a. IEC 60529: 1989+AMD1:1999+AMD2:2013 CSV Consolidated version. - Degrees of Protection Provided by Enclosures (IP Code).

### 1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
  - 1. CT: Current Transformer
  - 2. GFEP: Ground fault equipment protection
  - 3. LP: Lighting Panel
  - 4. MCB: Miniature circuit breaker
  - 5. MCCB: Molded-case circuit breaker
  - 6. NRTL: Nationally Recognized Testing Laboratory
  - 7. OCPD: Overcurrent protective device
  - 8. SPD: Surge Protective Device
  - 9. Zigbee: an open global standard wireless technology that uses low-power digital radio signals

### 1.4 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittals and Section 26 00 00 Electrical, in addition to those specified herein.
  - 1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
  - 2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show

the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

- B. Product Data: For each type of panelboard:
  - 1. Bus Materials, OCPDs, SPDs, and accessories indicated.
  - 2. Dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 3. Installation instructions complying with NEMA PB 1.1.
- C. Shop Drawings: Submit the following additional shop drawing information for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.
  - 1. Drawings shall include but not be limited to environmental protection; interior mounting dimensions; and wiring gutter dimensions.
  - 2. The location of the main shall be clearly shown.
  - 3. The location of the branches and solid neutral shall be clearly shown.
  - 4. Shop drawings shall illustrate one-line diagrams with applicable voltage systems.
- D. Operations and Maintenance Manuals:
  - 1. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
  - 2. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 10 years.
  - 1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
  - 2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.
- B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Process controllers, assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent

condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

#### 1.7 WARRANTY

- A. General: Refer to Section 01 77 00 - Closeout Procedures.
- B. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
- C. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of 1 year from the date of installation or 18 months from the date of purchase.

#### 1.8 SPECIAL TOOLS AND SPARE PARTS

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
  - 1. Contact information for the closest parts stocking location to the Owner.
  - 2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
  - 3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- B. Spare parts shall be provided for each type and size of unit furnished. At a minimum, the following shall be provided:
  - 1. Provide the minimum spare parts recommended by the manufacturer.
- C. Any manufacturer specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts, shall be furnished. At a minimum the following shall be provided:
  - 1. If available from manufacture, provide PC-based configuration software tool and a minimum of [one] communication interface cable for each type of cable required to connect a PC-based computer to the devices specified herein for configuration and programming.
  - 2. Electronic configuration files, in a media format acceptable by the Owner (e.g. CD, USB stick, etc.), updated to an as installed and commissioned state.
- D. Spare parts shall be properly marked and packaged for long term storage.



## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Acceptable Products: Panelboards specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:
1. Eaton
  2. GE/ABB
  3. Square D
  4. Siemens
- B. Panelboards shall be manufactured in accordance with standards listed within the Article 1.2 REFERENCES.

### 2.2 PANELBOARDS

- A. Interiors:
1. Panelboards shall be rated for:
    - a. 240Vac maximum, with continuous main current ratings, as indicated on associated schedules and the Drawings, not to exceed 600 amperes.
    - b. 480Y/277Vac maximum, with continuous main AC current ratings, as indicated on associated schedules and the Drawings, not to exceed 800 amperes.
    - c. Maximum current ratings shall apply for main lug only or main circuit breaker panelboards.
    - d. Panelboard ratings (bus ratings, heat rise, etc.) shall be conducted in accordance with, and certified by UL, as per UL67.
    - e. Main lug interiors up to 600 amperes shall be field convertible to main breaker.
  2. Provide UL-listed short circuit current ratings (SCCR) as indicated on the associated schedules and the Drawings, not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. The panelboard shall be rated for the minimum short circuit current rating in rms symmetrical amperes:
    - a. 240 Vac max panelboards shall be:
      - 1) at 240 Vac:
        - a) Fully rated to 22,000
    - b. 480Y/277Vac max panelboards shall be:
      - 1) at 240 Va:
        - a) Fully rated to: 22,000
      - 2) at 480Y/277 Vac:
        - a) Fully rated to: 35,000
  3. Each bus bar shall have sequentially phased branch circuit connectors.

- a. The bussing shall be fully rated, with one (1) continuous bus bar per phase, unless a Split Bus or Separated Distribution panel is specified:
    - 1) up to 84 circuits for 240 Vac maximum panelboards,
    - 2) Up to 54 circuits for 480Y/277 Vac max panelboards up to 54 circuit spaces.
    - 3) For Split Bus and Separated Distribution panelboards – provide one (1) continuous bus bar per phase for each branch distribution section.
      - a) Split Bus panelboard sections shall be connected from upstream lugs or branch breaker to one (1) back-fed main breaker in downstream section.
      - b) Separated Distribution panelboard sections shall be connected via removable, stranded copper cables, (to enable field installation of solid core CTs) secured via mechanical lugs on each section.
  - b. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
  - c. Bussing rated 100-400 amperes shall be plated copper. Bussing rated at or above 600 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar.
  - d. Interior phase bus shall be pre-drilled to accommodate field installable options i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs.
  - e. 240 Vac maximum panelboards shall have branch circuit connectors suitable for both plug-on and bolt-on branch circuit breakers.
4. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
    - a. A solidly bonded copper equipment ground bar shall be provided.
  5. Neutral shall be plated, solid, and split for 20” nominal and wider panelboards. 14” wide and column width panelboards shall have a plated solid neutral.
  6. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting spaces.
  7. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA and UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
  8. Interiors in NEMA 1 or 2 enclosures shall be field convertible for top or bottom incoming feed. Interior leveling provisions shall be provided for flush mounted applications.
  9. Main circuit breakers in 240 Vac max panelboards shall be horizontally mounted up to 150A. All other main circuit breakers shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted.
  10. Main circuit breakers in 480Y/277 max panelboards shall be horizontally mounted up to 125A at 480Y/277Vac. All other main circuit breakers shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted.
  11. 240 Vac max. IP2X Fingersafe interiors shall have thermoplastic bus covers installed such that, when branch circuit breakers are installed with thermoplastic covers, they provide IP2X per IEC 60529 ingress protection. (Therefore, if a specified metal jointed test finger is applied with 10 Newtons of force, it will not come into contact with any

live (ungrounded) parts.)

B. Enclosures

1. Type 1 Boxes

- a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 and UL50E requirements. Unpainted galvanized steel is not acceptable.

2. Type 1 Fronts

- a. Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel baked onto cleaned phosphatized steel.
- b. Fronts shall be hinged 1-piece with door. Mounting shall be as indicated on associated schedules or drawings.
- c. Doors on front shall have rounded corners and edges shall be free of burrs.
- d. Front shall have cylindrical tumbler type lock with catch and spring-loaded steel door pull, quarter-turn fasteners, or three-point latch. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder, or welded metal frame directory cardholder, shall be mounted on the inside of door.

3. Type 3R, 5, and 12

- a. Enclosures shall be constructed in accordance with UL 50 and UL50E requirements. Enclosures shall be painted with ANSI 49 gray enamel baked onto cleaned phosphatized steel.
- b. All doors shall be equipped with at least one L-Handle lock mechanisms. Enclosures 59 inches or more in height shall have additional L-Handle mechanisms or two (2) additional quarter turn fasteners. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder, or welded metal frame directory cardholder, shall be mounted on the inside of door. Doors in enclosures which may configured for NEMA 5 or 12 service shall be gasketed.
- c. Nominal enclosure dimensions shall be:
  - 1) 21" wide and 6.75" deep, not counting the handle, for standard Type 3R, 5, 12.
  - 2) 21" wide and 8.75" deep, not counting the handle, for Door-in-door Type 12.
  - 3) 27" wide and 8.75" deep, not counting the handle, for vented NEMA Type 3R.

4. Type 4, 4X

- a. Enclosures shall be constructed in accordance with UL 50 and UL 50E requirements.
- b. All doors shall be gasketed and equipped with a L-Handle mechanism with additional clamps or fasteners on the top, bottom, and/or side to ensure tight closure. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder, or welded metal frame directory cardholder, shall be mounted on the inside of door.
- c. Nominal enclosure dimensions shall be 20.13" wide and 7.25" deep, not

counting the handle.

## 2.3 MAIN CIRCUIT BREAKER

- A. Main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Main circuit breakers shall have Thermal Magnetic trip units.
  - 1. Thermal Magnetic circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
- B. Two- and three-pole circuit breakers shall have common tripping of all poles. Vertically mounted molded case circuit breaker frame sizes above 125 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Molded case circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
- C. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
- D. Vertically mounted main circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
- E. Lugs shall be CSA and UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75° C rated wire. Lug body shall be bolted in place; snap-in designs are not acceptable.
- F. The circuit breakers shall be CSA and UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

## 2.4 BRANCH CIRCUIT BREAKERS

- A. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated schedules or drawings.
- B. Molded case branch circuit breakers in 240 Vac maximum panelboards shall bolt-on or plug-on to the bus, and shall not require additional external mounting hardware, except when installed into IP2X enhanced fingersafe interiors.
  - 1. Branch circuit breakers shall be available with the following nominal interrupting ratings:
    - a. 1 pole: 10A - 70A
    - b. 2 poles: 15 - 125A (up to 200A in a single phase. panelboard)
    - c. 3 poles: 15 -125A
- C. Molded case branch circuit breakers in 480Y/277 Vac maximum panelboards shall bolt-on to the bus and shall not require additional external mounting hardware.
  - 1. Branch circuit breakers shall be available with the following nominal interrupting ratings:
    - a. 1 pole: 10A - 70A

- b. 2 poles: 15 - 125A
- c. 3 poles: 15 – 125A
- D. Circuit breakers shall have an over center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and shall be factory-calibrated to operate in a 40 degrees C ambient environment. Circuit breakers shall have an operating range from – 10 degrees C to + 60 degrees. Thermal elements shall be ambient compensating above 40 degrees C.
- E. Two- and three-pole circuit breakers shall have common tripping of all poles.
- F. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red, Visi-Trip indicator appearing in the clear window of the circuit breaker housing.
- G. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 75° C rated wire. Branch circuit breakers rated 30 amperes and below shall be CSA and UL Listed to accept 60° C rated wire.
- H. Circuit Breakers shall be CSA and UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch

## 2.5 SURGE PROTECTIVE DEVICES

- A. Surge protective devices shall be electrically connected to each phase bus of the panelboard and should be installed close to the main incoming lugs or main circuit breaker.
- B. Field installable surge protective devices shall attach to the bus in the branch circuit section and shall be from same manufacturer as the panelboard.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 26 00 00 and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- F. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory trained manufacturer's representative field service engineer. Test and adjust

- controls and safeties. Replace damaged or malfunctioning controls and equipment. Report to the Engineer any discrepancies or issues with the installation.
- G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

### 3.2 INSTALLATION

- A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

**END OF SECTION**

**SECTION 26 27 00.11  
MINI-POWER CENTERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The CONTRACTOR shall furnish and install single-phase and three-phase general purpose individually mounted mini-power centers of the two-winding type, self-cooled, as specified herein and as shown on the contract drawings.

**1.2 REFERENCES**

- A. The mini-power center and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL, ANSI and NEMA.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. For review/approval: The following information shall be submitted to the ENGINEER:
  - 1. Dimension drawing weights
  - 2. Transformer ratings including:
    - a. kiloVoltAmp
    - b. Primary and secondary voltage
    - c. Taps
    - d. Primary and secondary continuous current
    - e. Insulation class and temperature rise
    - f. Sound level
  - 3. Component ratings including:
    - a. Voltage
    - b. Continuous current
    - c. Interrupting ratings
  - 4. Cable terminal sizes
  - 5. Product data sheets.
- B. For construction. The following information shall be submitted for record purposes:
  - 1. Final (as-built) drawings and information for items listed above, and shall incorporate all changes made during the manufacturing process
  - 2. Connection diagrams
  - 3. Installation information

**1.5 QUALITY ASSURANCE**

- A. The manufacturer of the assembly shall be the manufacturer of the secondary distribution equipment.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

#### 1.7 SITE CONDITIONS - NOT USED

#### 1.8 WARRANTY - NOT USED

#### 1.9 REGULATORY REQUIREMENTS

- A. The assembly and all components shall be UL listed.

#### 1.10 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and instruction bulletins for the complete assembly and for each major component.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with the requirements of this Section, provide products by one of the following:
  1. Eaton Corporation; Cutler-Hammer Products.
  2. General Electric Company; GE Industrial Systems.
  3. Square D; Schneider Electric.
  4. Siemens

#### 2.2 RATINGS

- A. kVA and voltage ratings shall be as shown on the drawings.
- B. Units shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
- C. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:
  1. Up to 9 kVA 40 dB
  2. 10-30 kVA 45 dB

#### 2.3 CONSTRUCTION

- A. Each mini-power center shall include a primary main breaker, an encapsulated dry-type transformer and a panelboard with secondary main breaker.
- B. Primary main, secondary main and feeder breakers shall be enclosed with a padlockable hinged door.
- C. Mini-power centers shall be suitable for service entrance application and labeled as such.



D. Insulation Systems

1. Transformers shall be insulated with a 180°C insulation system and rated at 115°C temperature rise
2. Required performance shall be obtained without exceeding the above-indicated temperature rise in a 40°C maximum ambient, with a 30°C average over 24 hours
3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635

E. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of copper with continuous wound construction.
2. The core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level.
3. The core of the transformer shall be grounded to the enclosure
4. Provide two 5% FCBN taps

2.4 BUS

- A. Secondary bus shall be copper.

2.5 WIRING/TERMINATIONS

- A. All interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer and distribution section shall be factory installed.
- B. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

2.6 MAIN DEVICES

- A. Each mini-power center shall include a primary main breaker with an interrupting rating of 14 kA at 277/480 V; and a secondary main breaker with an interrupting rating of 10 kA at 120/240 V and a panelboard.

2.7 FEEDER DEVICES

- A. The secondary distribution section shall accommodate one-inch plug-in breakers with 10 kA interrupting capacity.

2.8 ENCLOSURE

- A. The enclosure shall be made of heavy-gauge steel and the maximum temperature of the enclosure shall not exceed 90°C.
- B. The enclosure shall be totally enclosed, nonventilated, NEMA 4X SST, with latching handle.

## PART 3 - EXECUTION

### 3.1 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA.
  - 1. Ratio tests at the rated voltage connection and at all tap connections
  - 2. Polarity and phase-relation tests on the rated voltage connection
  - 3. Applied potential tests
  - 4. Induced potential test
  - 5. No-load and excitation current at rated voltage on the rated voltage connection

### 3.2 INSTALLATION

- A. The CONTRACTORS shall install all equipment per the manufacturer's recommendations and the contract drawings.

### 3.3 FIELD ADJUSTMENTS

- A. Adjust taps to deliver appropriate secondary voltage.

### 3.4 FIELD TESTING

- A. Measure primary and secondary voltages for proper tap settings.

**END OF SECTION**

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and install wiring devices as shown on the Drawings and as specified herein.
- B. Provide all interconnecting conduit and branch circuit wiring for receptacle circuits in accordance with the NEC.

**1.2 RELATED WORK**

- A. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

**1.3 SUBMITTALS**

- A. Submittals shall be in accordance with Section 26 00 00 - Electrical General Provisions.

**1.4 REFERENCE STANDARDS**

- A. Wiring devices shall comply with the requirements of the National Electric Code (NEC) and shall be Underwriters Laboratories (UL) labeled.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

**2.2 WALL SWITCHES**

- A. Wall switches shall be heavy duty, specification grade, toggle action, flush mounting quiet type. All switches shall conform to the latest revision of Federal Specification WS 896. Wall switches shall be suitable for the area classification indicated and shall be of the following types and manufacturer:
  - 1. Single pole, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 2. Double pole, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 3. Three way, 20 Amp, 120/277 Volt - Cooper Wiring Devices, Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 4. Four way, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 5. Single pole, 20 Amp, 120/277 Volt - key operated, Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 6. Single pole, 20 Amp, 120 Volt - red pilot-lighted handle, Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 7. Single pole, 20 Amp, 120 Volt, clear lighted handle, Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 8. Momentary contact, three position, 2 circuit, center off - Cooper Wiring Devices;

Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

- B. Fluorescent wall box dimmer switch for 120/277 Volt control of rapid start fluorescent lamps with a dimming range of 100 percent to 0.5 percent light for 120 Volt and 100 to 1 percent light for 277 Volt shall be compatible with dimming ballast. Dimmer switch controls shall be as manufactured by Lutron Electronics Inc.; Lithonia Lighting; Pass & Seymour, Inc. or equal.
- C. Explosion-proof single pole factory sealed switches shall be for 20 Amps, 120/277 volts, mounted in copper free aluminum or malleable iron cast boxes and be similar and equal to Crouse-Hinds EDS Series, Appleton Electric Co. EDS; Hubbell HBL or equal.

### 2.3 RECEPTACLES

- A. Receptacles shall be heavy duty, specification grade of the following types and manufacturer or equal. Receptacles shall conform to Fed Spec WC596-F.
  - 1. Duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 2. Weatherproof/corrosion resistant single, 20 Amp, 125 Volt, 2 Pole, 3 Wire, with cover; Crouse-Hinds Co., Catalog No. WLRS-5-20; Appleton Electric FSKJ520; Pass & Seymour or equal.
  - 3. Corrosion resistant duplex, 20 Amp, 125 Volt, 2-pole, 3-wire, high visibility yellow nylon face, nickel plated brass or copper alloy power contacts, Cooper-Arrow/Hart Catalog No. 5362CRY; Hubbell Catalog No. HBL53CM62; Bryant-Electric Catalog No. BRY5362CR; or equal.
  - 4. Weather & tamper resistant ground fault interrupter, duplex, 20 Amp, 125 Volt, 2-pole, 3-wire, gray nylon face, Cooper Wiring Devices Catalog No. TWRVG20GY; Hubbell Catalog No. GFTR20GY; Bryant-Electric Catalog No. GFTR20GY; or equal.
  - 5. Ground fault interrupter, duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire, GFCI feed thru type with "test" and "reset" buttons. Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 6. Duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire, transient voltage surge suppressor and audio alarm or indicating light to indicate bad ground or failed MOV. Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 7. Clock hanger single, 15 Amp, 125 Volt, 2 Pole, 3 Wire, with hanging hook on device plate. Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 8. Single, "power lock", 20 Amp, 125 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 9. Single, 20 Amp, 250 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.
  - 10. Single twist-lock, 30 Amp, 125 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices; Arrow Hart, Pass & Seymour, Inc. or equal.
  - 11. Single twist-lock with matching plug, 20 Amp, 250 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices; Arrow Hart, Pass & Seymour, Inc. or equal.
  - 12. Single twist-lock with matching plug, 30 Amp, 250 Volt, 2 Pole, 3 Wire; Arrow-Hart, or similar by Harvey Hubbell, Inc.; Pass & Seymour, Inc. or equal.

13. Explosion-proof and factory sealed Class 1, Divisions 1&2, Groups C&D; wet location rated; delayed action; minimum 115 – 230Vac; 2-wire; 3-pole; angle receptacle with spring cover and cast or malleable iron back box; matching plug:
  - a. Single gang (singlex): Cooper Crouse-Hinds CPS152-xx1 (receptacle); CPP516 (plug); Appleton Electric; Hubbell-Killark; or equal.
  - b. Two gang (duplex): Cooper Crouse-Hinds CPS152-xx2 (receptacle); two (2) CPP516 (plugs); Appleton Electric; Hubbell-Killark; or equal.
14. Explosion-proof and factory sealed Class 1, Divisions 1&2, Groups C&D; wet location rated; interlocked circuit breaking; minimum 125 – 250Vac; 2-wire; 3-pole; angle receptacle with spring cover and cast or malleable iron back box (receptacle shall NOT accept non-explosion proof standard NEMA configuration plugs); matching plug (plug shall fit any non-explosion proof receptacle (NEMA 5-20R, 6-20R)).
  - a. Single gang (singlex): Cooper Crouse-Hinds ENRxx1201 (receptacle); ENP5201 (plug); Appleton Electric; Hubbell-Killark; or equal.
  - b. Two gang (duplex): Cooper Crouse-Hinds ENRxx2201 (receptacle); two (2) ENP5201 (plugs); Appleton Electric; Hubbell-Killark; or equal.

#### 2.4 DEVICE PLATES

- A. Plates for indoor flush mounted devices shall be of the required number of gangs for the application involved and shall be as follows:
- B. Administration type buildings: Smooth, high impact nylon of the same manufacturer and color as the device. Final color shall be as selected by the Architect.
  1. Where permitted in other areas of the plant, flush mounted devices in cement block construction shall be Type 302 high nickel (18-8) stainless steel of the same manufacturer as the devices.
  2. Plates for indoor surface mounted device boxes shall be cast metal of the same material as the box, Crouse-Hinds No. DS23G and DS32G; Appleton FSK1DRC, FSK1TSEC; Pass & Seymour or equal.
- C. Oversized plates shall be installed where standard plates do not fully cover the wall opening.
- D. Device plates for switches mounted outdoors or indicated as weatherproof shall be gasketed, cast aluminum with provisions for padlocking switches "On" and "Off", Crouse Hinds No. DS185; Appleton FSK1VS; Pass & Seymour or equal.
- E. Multiple surface mounted devices shall be ganged in a single, common box and provided with an adapter, if necessary, to allow mounting of single gang device plates on multigang cast boxes.
- F. Engraved device plates shall be provided where required.
- G. Weatherproof, gasketed cover for GFI receptacle mounted in a FS/FD box shall be Cooper Crouse-Hinds; RACO (Hubbell); Pass & Seymour, Inc. or equal.
- H. Weatherproof metallic 'Not Attended/While-In-Use' cover, UV & powder die-cast metal construction, minimum 3-1/2 in deep cover, gasketed, horizontal or vertical mounting as required, single or double gang as required, lockable hasp, as manufactured by Thomas & Betts (Red Dot); TayMac; Orbit Electric; or equal.

- I. Weatherproof (with plug NOT inserted) cover, lift-lid, single or double gang as required, corrosion resistant die-cast construction, self closing stainless steel spring doors, screw attach to FS, FD or other device boxes, EPDM gasket on base of cover (not in lid) surrounding receptacle providing protection while plug is installed, as manufactured by Cooper Crouse-Hinds WLRS (or WLRD), Appleton FSK-WR1 (or -WRD); Arrow-Hart; or equal.

## 2.5 THREE PHASE POWER RECEPTACLES

- A. Three phase power receptacles and plugs shall be rated for the voltage and current ratings of the connected load unless otherwise shown on the Drawings.
- B. Receptacles and plug housings shall be constructed of copper free aluminum listed to UL Standard 498 for watertight construction. Hardware shall be stainless steel.
- C. Performance
  1. Maximum working voltage: 600 Volts RMS.
  2. Dielectric withstand voltage: 3000 Volts.
  3. Full load break capability at rated current.
  4. 5000 connect/disconnect cycles at rated voltage and current.
- D. Furnish and install one mating plug with each receptacle.
- E. Provide the following features:
  1. Color coded by voltage.
  2. One piece housing/angled backbox
  3. Shrouded pins
  4. Self closing gasketed cover.
  5. Watertight cable entrances/stress relief grips.
  6. Mating keys.
- F. Acceptable manufacturers:
  1. Hubbell
  2. Appleton
  3. Cooper Crouse-Hinds

## 2.6 INTERLOCKED THREE PHASE POWER RECEPTACLES

- A. Interlocked three phase power receptacles shall include a combination receptacle and a mechanically interlocked disconnect switch. The two units shall be interlocked to prevent removal or insertion of the plug unless the switch is in the OFF position.
- B. Provide a matching plug for every unit furnished.
- C. Switch, power receptacle and mating plug shall be constructed of copper free aluminum.
- D. Assemble shall be listed to UL Standard 498 for watertight- construction.
- E. Hardware shall be stainless steel.
- F. Performance:
  1. Maximum working voltage: 600 Volts RMS.
  2. Dielectric withstand voltage: 3000 Volts.

3. Full load break capability at rated current.
  4. 5000 connect/disconnect cycles at rated voltage and current.
- G. Provide the following features:
1. Color coded by voltage.
  2. One piece housing/angled backbox
  3. Shrouded pins
  4. Self closing gasketed cover.
  5. Watertight cable entrances/stress relief grips.
  6. Mating keys.
- H. The disconnect switch shall be [unfused] [fused] with ratings as hereinbefore specified. Provide lockout provisions on the disconnect switch handle.
- I. Acceptable manufacturers:
1. Crouse-Hinds
  2. Appleton
  3. Killark (Hubbell)
  4. Hubbell

## 2.7 POKE-THRU SERVICE FITTINGS

- A. Poke-thru service fittings shall be installed in a 2-in core drilled hole, fit floor thicknesses of 2-1/2-in to 7-in and be fire rated.
- B. Poke-thru service fittings shall be barriered to handle both high and low tension services and be designed for both new construction and building retrofit.
- C. Service fitting heads shall each contain a 20 Amp, 125 Volt, 2 Pole, 3 Wire duplex receptacle on one side and provisions for up to 2-25 pair telephone cables on the remaining side.
- D. Complete poke-thru services fitting shall be as manufactured by Wiremold; Hubbell Wiring Devices; Steel City (Thomas & Betts); Walker or equal.

## 2.8 WALL SWITCH OCCUPANCY SENSORS – SMALL AREAS

- A. Sensor shall recess into single gang switch box and fit a standard GFCI opening.
- B. Sensor must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (OFF) condition.
- C. Sensor shall use Passive Infrared (PIR) sensing incorporating a nominal one half inch focal length lens viewing 9 inches above and below horizontal view pattern measured at 10 feet.
- D. Sensor shall optional features for photocell/daylight override, vandal resistant lens, and no switch as specified.
- E. In areas with inboard/outboard switching, sensor shall provide two dedicated relays and override switches. Each relay shall have independent programmable time delays.
- F. In areas with obstructions to the occupant's workspace, sensor shall utilize programmable

dual technology PIR/Microphonic Passive Dual Technology (PDT) sensing.

- G. Ultrasonic or Microwave based sensing technologies will not be acceptable.
- H. All models shall "Reduced Turn On". This is a field programmable function for problematic areas with unforeseen reflective surfaces. False turn on shall be eliminated with this feature.
- I. Sensor shall be UL Listed and warranted for 5 years.
- J. Sensor shall be the following model as manufactured by Sensor Switch, Inc., or equal. Device color and optional features as specified.
  - 1. WSD (PIR)
  - 2. WSD-2P (PIR inboard/outboard)
  - 3. WSD-PDT (PIR/Microphonic)
  - 4. WSD-PDT-2P (PIR/Microphonic inboard/outboard)
  - 5. WSD-SA (PIR Semi-Automatic)
  - 6. WSD-PDT-SA (PIR/Microphonic Semi-Automatic)

## 2.9 WALL SWITCH OCCUPANCY SENSORS – LARGE AREAS

- A. Sensor shall recess into single gang switch box and fit a standard GFCI opening.
- B. Sensor must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (OFF) condition.
- C. Sensor shall use Passive Infrared (PIR) sensing incorporating a nominal one-inch focal length lens viewing 9 inches above and below horizontal view pattern measured at 20 feet.
- D. Sensor shall optional features for photocell/daylight override, vandal resistant lens, and no switch as specified.
- E. In areas with inboard/outboard switching, sensor shall provide two dedicated relays and override switches. Each relay shall have independent programmable time delays.
- F. In areas with obstructions to the occupant's workspace, sensor shall utilize programmable dual technology PIR/Microphonic Passive Dual Technology (PDT) sensing.
- G. Ultrasonic or Microwave based sensing technologies will not be acceptable.
- H. All models shall "Reduced Turn On". This is a field programmable function for problematic areas with unforeseen reflective surfaces. False turn on shall be eliminated with this feature.
- I. Sensor shall be UL Listed and warranted for 5 years.
- J. Sensor shall be the following model as manufactured by Sensor Switch, Inc., or equal. Device color and optional features as specified.
  - 1. LWS (PIR)
  - 2. LWS-2P (PIR inboard/outboard or two circuits)
  - 3. LWS-PDT (PIR/Microphonic)
  - 4. LWS-PDT-2P (PIR/Microphonic inboard/outboard or two circuits)
  - 5. WSD-SA (PIR Semi-Automatic)



6. WSD-PDT-SA (PIR/Microphonic Semi-Automatic)

2.10 CEILING MOUNTED OCCUPANCY SENSORS

- A. Occupancy sensors shall be provided in areas as shown on the Drawings. Sensor shall be line voltage, microprocessor based ultrasonic and infrared unit with adjustable sensitivity and time delay functions, LED indicator lamp and self-contained relay for switching the lighting load. Sensors shall be CMR-PDT-9 as manufactured by Sensorswitch, Inc., or similar by Watt Stopper, Leviton Manufacturing Co., or approved equal.
- B. Occupancy sensors shall be ceiling mounted and wired into the 120 Volt lighting circuits ahead of the area switch controls so that the occupancy sensor shall activate lights in their "as-left" switched state.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Switch and receptacles outlets shall be installed flush with the finished wall surfaces in areas with stud frame and gypsum board construction, in dry areas with cement block construction or when raceways are shown as concealed on the Drawings.
- B. Do not install flush mounted devices in areas designated DAMP, WET or WET/CORROSIVE on the Drawings. Provide surface mounted devices in these areas.
- C. Where individual ground fault interrupter type receptacles are shown on the Drawings connected to the same circuit, the Contractor shall provide all ground fault interrupter type receptacles. Use of one ground fault interrupter type receptacle to protect downstream conventional receptacles is unacceptable.
- D. Provide corrosion resistant receptacles and 'While-In-Use' weatherproof covers in areas designated CORROSIVE on the Drawings.
- E. Convenience outlets shall be 18-in above the floor unless otherwise required or shown on the Drawings.
- F. Convenience outlets installed in rooms designated as WET or where equipment may be hosed down shall be mounted minimum 48-in above deck or grade (or as shown on the Drawings) and shall be weather & tamper resistant, ground fault circuit interrupter type, installed within a 'While-In-Use' weatherproof cover.
- G. Convenience outlets mounted outdoors shall be mounted minimum 48-in above deck or grade (or as shown on the Drawings) and shall be weather & tamper resistant, ground fault circuit interrupter type, installed within a 'While-In-Use' weatherproof cover.
- H. Switches and dimmer controls for lighting shall be mounted 48-in above the finished floor unless otherwise noted or required.
- I. The location of all devices is shown, in general, on the Drawings and may be varied within reasonable limits so as to avoid any piping or other obstruction without extra cost, subject to the approval of the Engineer. Coordinate the installation of the devices for piping and equipment clearance.

### 3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
  - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

**END OF SECTION**

**SECTION 26 27 29**  
**SWITCH RATED PLUGS AND RECEPTACLES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Furnish all labor, materials, equipment and install wiring devices as shown on the Drawings and as specified herein.
- B. Provide all interconnecting conduit and branch circuit wiring for receptacle circuits in accordance with the NEC.
- C. Related Sections:
  - 1. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

**1.2 REFERENCES**

- A. Wiring devices shall comply with the requirements of the National Electric Code (NEC) and shall be Underwriters Laboratories (UL) labeled.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Submittals shall be in accordance with Section 26 00 00 - Electrical General Provisions.

**1.5 QUALITY ASSURANCE - NOT USED**

**1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED**

**1.7 SITE CONDITIONS - NOT USED**

**1.8 WARRANTY - NOT USED**

**PART 2 - PRODUCTS**

**2.1 SWITCH RATED PLUGS AND RECEPTACLES**

- A. Plugs and receptacles must be listed to UL 2682 'Switch Rated Plugs and Receptacles.' (Alternate for Canada: Plugs and receptacles must be CSA listed to UL 2682 'Switch Rated Plugs and Receptacles').
- B. Plugs and receptacles must have constant pressure butt-contacts with solid silver-nickel tips. Pin and sleeve contacts are not permitted.
- C. Receptacles must have dead front construction: live parts must be inaccessible to thin tool or wire.
- D. Plugs and receptacles must be able to close at least once on a conditional short-circuit current of 65,000A. (Short circuit testing should be performed with RK1 current limiting fuses sized at 400% of the highest full load motor ampacity associated with the device).
- E. Plugs and receptacles must incorporate an integral switching mechanism to ensure the load is broken before the plug is removed from the receptacle.

- F. Plug and receptacle wire terminals must be spring-assisted to prevent loosening due to conductor yielding, shocks, vibrations or thermal cycling.
- G. The minimum environmental rating of plugs and receptacles must be Type 3R (DS Series), Type 4X and IP66/IP67/IP69K (DSN Series), or IP67 (DB Series).
- H. Ingress protection must be achieved automatically when the plug is fully inserted into the receptacles, without additional manual operation (except DB Series).
- I. Plugs and receptacles must have a system of different keying positions in order to discriminate between circuits or incompatible operating voltages or frequencies.
- J. Plugs and receptacles installed outdoor must be able to withstand UV radiation.
- K. Plugs and receptacles shall be MELTRIC Switch-Rated Series or equal.

## 2.2 HAZARDOUS DUTY RATED PLUGS AND RECEPTACLES

- A. Plugs and receptacles shall be UL or CSA rated for Class I Division 2 Group A, B, C, D and Class II Division 2 Group E, F, G environments.
- B. Plugs and receptacles shall be rated to ATEX II 2 G/D DUST T85 EEx ed IIC T6.
- C. The minimum environmental rating of plugs and receptacles must be IP 66+67. Ingress Protection must be achieved automatically when the plug is fully inserted into the receptacles, without any additional manual operation.
- D. Receptacles shall have a dead front, live parts must be inaccessible to a thin tool or wire.
- E. Plugs and receptacles shall have constant pressure butt-contacts with solid silver-nickel contact tips. Pin and sleeve contacts are not permitted.
- F. Plugs and receptacles shall be able to safely connect and disconnect equipment under full load in potentially explosive environments.
- G. Hazardous duty rated plugs and receptacles shall be MELTRIC DXN Series or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Switch and receptacles outlets shall be installed flush with the finished wall surfaces in areas with stud frame and gypsum board construction, in dry areas with cement block construction or when raceways are shown as concealed on the Drawings.
- B. Do not install flush mounted devices in areas designated DAMP, WET or WET/CORROSIVE on the Drawings. Provide surface mounted devices in these areas.
- C. Where individual ground fault interrupter type receptacles are shown on the Drawings connected to the same circuit, the Contractor shall provide all ground fault interrupter type receptacles. Use of one ground fault interrupter type receptacle to protect downstream conventional receptacles is unacceptable.
- D. Provide corrosion resistant receptacles and 'While-In-Use' weatherproof covers in areas designated CORROSIVE on the Drawings.
- E. Convenience outlets shall be 18-in above the floor unless otherwise required or shown on the Drawings.

- F. Convenience outlets installed in rooms designated as WET or where equipment may be hosed down shall be mounted minimum 48-in above deck or grade (or as shown on the Drawings) and shall be weather & tamper resistant, ground fault circuit interrupter type, installed within a 'While-In-Use' weatherproof cover..
- G. Convenience outlets mounted outdoors shall be mounted minimum 48-in above deck or grade (or as shown on the Drawings) and shall be weather & tamper resistant, ground fault circuit interrupter type, installed within a 'While-In-Use' weatherproof cover.
- H. Switches and dimmer controls for lighting shall be mounted 48-in above the finished floor unless otherwise noted or required.
- I. The location of all devices is shown, in general, on the Drawings and may be varied within reasonable limits so as to avoid any piping or other obstruction without extra cost, subject to the approval of the Engineer. Coordinate the installation of the devices for piping and equipment clearance.

**END OF SECTION**

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**SECTION 26 28 16**  
**ENCLOSED SWITCHES AND CIRCUITS BREAKERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Fusible (blade) switches.
  - 2. Nonfusible (blade) switches.
  - 3. Nonfusible (rotary) switches.
  - 4. Molded-case circuit breakers (MCCBs).

**1.2 SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  - 1. manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

**1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items.
- C. Comply with indicated maximum dimensions.

- D. 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.
- E. Comply with NFPA 70.

#### 1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22° F and not exceeding 120° F.
  - 2. Altitude: Not exceeding 6,600 feet.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

#### 1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

### PART 2 - PRODUCTS

#### 2.1 FUSIBLE (BLADE) SWITCHES

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Rockwell Automation; Allen Bradley
  - 4. Square D; Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600 Vac, 1,200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept 3 padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 4. Service-Rated Switches: Labeled for use as service equipment.



## 2.2 NONFUSIBLE (BLADE) SWITCHES

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Rockwell Automation; Allen Bradley
  - 4. Square D; Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600 Vac, 1,200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept 3 padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.3 NONFUSIBLE (ROTARY) SWITCHES

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Rockwell Automation; Allen Bradley
  - 4. Square D; Schneider Electric.
- B. Ratings
  - 1. The non-fusible rotary disconnect switches shall have UL ratings in 100, 200, 400, 600, 800, and 1200A sizes (at 600 VAC), with power/voltage as indicated on the drawings.
- C. Construction
  - 1. Switch
    - a. The non-fusible rotary disconnect switches shall have a compact design and high resistance to humidity.
    - b. Each non-fusible rotary disconnect switch shall be a 3- or 4-pole version, as indicated on the drawings.
  - 2. Operating Shafts and Handles
    - a. The non-fusible rotary disconnect switches shall have 12 inch or 22 inch operating shafts.
    - b. Rotary operating handles shall be matte black with defeater, ingress rated NEMA 4X.
- D. Accessories
  - 1. The non-fusible rotary disconnect switches shall accommodate up to 2 N.O./N.C. Form C contacts.

2. Terminal shields shall offer line and load protection against contact with terminals.
3. Line and load lugs shall be suitable for single- or dual-conductor applications.
4. Bolt kits shall be supplied for adapting lugs or ring/crimp conductors.

#### 2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  1. Eaton Corporation; Cutler-Hammer Products.
  2. General Electric Company; GE Industrial Systems.
  3. Square D; Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

#### 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Air Conditioned Locations: NEMA 250, NEMA 12.
  2. Indoor, Ventilated, Dry and Clean Locations: NEMA 250, NEMA 4X Type 316 Stainless Steel.
  3. Outdoor Locations: NEMA 250, NEMA 4X Type 316 Stainless Steel.
  4. Other Wet or Damp, Indoor Locations: NEMA 250, NEMA 4X Type 316 Stainless Steel.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.

- D. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section 26 05 53 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
  - 1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
  - 2. Assist in field testing of equipment, including pretesting and adjusting of automatic power factor correction units as applicable.
  - 3. Report results in writing.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection report, including a certified report that identifies enclosed

switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

**END OF SECTION**

**SECTION 26 29 03**  
**LOW-VOLTAGE PILOT CONTROL DEVICES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Furnish and install all equipment, accessories and materials in accordance with these specifications and drawings
- B. Electrical control devices for panels, motor controllers, control stations, etc. This Section includes the following:
  - 1. Pilot Devices
  - 2. Relays and Timers
  - 3. Miniature Circuit Breakers
  - 4. Terminal Blocks and Fuse Blocks
  - 5. Alarms and Signals
  - 6. Power Supplies
  - 7. Signal Conditioners/Isolators

**1.2 REFERENCES**

- A. Electrical control devices shall be designed, fabricated, and tested in accordance with the latest revision of the following standards.
  - 1. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 V Maximum).
    - b. ICS-2 Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V
  - 2. NFPA (National Fire Protection Association):
    - a. 70 National Electrical Code (NEC)
  - 3. Underwriters Laboratories (UL):
    - a. 508, Standard for Safety Industrial Control Equipment.
    - b. 508A, Standard for Safety Industrial Control Panels.

**1.3 ENVIRONMENTAL REQUIREMENTS**

- A. The supplier shall confirm specified service conditions during and after installation of products.
- B. The supplier shall maintain the area free of dirt and dust during and after installation of products.

**1.4 SUBMITTALS**

- A. Submittals shall be made in accordance with Submittal Procedures.
- B. Shop drawings (to NEMA ICS 1) shall be submitted to indicate control panel layouts, wiring connections and diagrams, dimensions and support points.
- C. Product data for each electrical control device specified shall be submitted and included as

part of the system in which the device is specified.

- D. The manufacturer's installation and user instructions shall be submitted, providing:
  - 1. Receiving, handling and storage instructions.
  - 2. Instructions for adjusting and resetting devices.
  - 3. Recommended preventive maintenance procedures.

## 1.5 QUALITY ASSURANCE

- A. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A.
  - 1. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Instruction Control Panel" prior to shipment to the jobsite.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Unless listed within the product description, product shall be subject to compliance with requirements and provided by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
  - 4. Square D; a brand of Schneider Electric.

### 2.2 PILOT DEVICES

- A. Push Buttons, Selector Switches and Pilot Lights
  - 1. Push buttons, Type 4/4X/13 corrosion-resistant/watertight/oiltight plastic, selector switches and pilot lights shall be 30.5 mm type.
  - 2. Push buttons, selector switches and pilot lights shall have electrical ratings of:
    - a. Dielectric strength: 2,200 V for 1 min.
    - b. Electrical design life cycles: 10,000,000 at maximum rated load
  - 3. Push buttons, selector switches and pilot lights shall have an operating range of minus 40-131°F (minus 40-55°C).
  - 4. Illuminated devices shall offer universal LED, push-to-test, that accepts 12-130 Vac/Vdc voltage input. Lens color shall be as follows:
    - 1) Running, on, open: Red.
    - 2) Stopped, off, closed: Green.
    - 3) Alarm: Amber.
    - 4) White: Power on
    - 5) Blue: All other status indications not covered by the above
    - 6) Lens caps shall be approximately 0.46-inch diameter. Provide legend faceplates engraved to indicate the required function of each device; NEMA 4X rating.
  - 5. Push buttons shall have a diaphragm seal for protection from liquids, particles and

corrosive agents. Button colors shall be as follows:

- 1) Start, open: Red.
  - 2) Stop, close: Green.
  - 3) Black: All other status indications not covered by the above
6. Selector switches shall incorporate a positive detent to prevent the switch from hanging up between positions.
    - a. Selector switches shall incorporate a positive detent to prevent the switch from hanging up between positions.
- B. Potentiometer Devices
1. Potentiometer devices shall be Type 4/4X/13 corrosion-resistant/watertight/oiltight plastic, 30.5 mm type.
  2. Potentiometer devices shall be rated for 300 Vac/Vdc, 2 W maximum (6 Vdc minimum):
    - a. Mechanical design life: Minimum 25,000 cycles
    - b. Rotational torque: 3-12 in/oz
    - c. Stopping torque: Minimum 12 in/lb.
  3. Potentiometer devices shall have single-turn operation, 312 degree rotation.
  4. Potentiometer devices shall be finger-safe.
- C. Elapsed Time Meters
1. Meter shall be heavy duty, electro-mechanical, non-resettable, 6 digit 99999.9h Unit shall be NEMA 4X rated.
  2. Mounting of unit with gasket shall maintain rating of enclosure.

## 2.3 OPERATOR CONTROL STATIONS

- A. Devices
1. Control stations shall be provided with heavy industrial 30.5 mm push button(s) or selector switch with appropriate contact action, button/lever type and color/legend marking. Devices shall be Type 4/4X/13 corrosion-resistant/watertight/oiltight plastic. Field mounted stop push buttons shall be supplied with pad lockable attachment to hold the button in position.
- B. NEMA 4/13 rated:
1. Die cast aluminum body with manufacturer's standard finish.
  2. Gasketed die cast aluminum cover with manufacturer's standard finish.
  3. Number of service mounting holes as required.
- C. NEMA 4X rated:
1. Type 316 stainless steel body.
  2. Gasketed Type 316 stainless steel cover.
  3. Number of service mounting holes as required.

## 2.4 RELAYS AND TIMERS

- A. Relays – Time Delay

1. Time delay relays shall mount on tube-type bases with pin-style socket mounting.
  2. Time delay relays shall have 10 amp, B300, DPDT contact ratings and coil voltages as shown on drawings.
  3. Time delay relays shall have adjustable timing ranges. Timing ranges shall be as shown on drawings.
- B. Relays – General Purpose
1. General purpose relays shall have tube-base/Octal 8-pin or 11-pin terminals and "ON" and "OFF" flag indicators.
  2. General purpose relay contacts shall be silver nickel and have 10 amp, B300, DPDT or 3PDT ratings. Coil voltages shall be as shown on drawings.
  3. General purpose relays shall have an electrical schematic on the faceplate, a clear cover for visual inspection and snap-in marker ability.
  4. General purpose relays shall have LED status indicators, push-to-test and manual override.
- C. Relays – Miniature
1. Miniature relays shall be square-base, 4-pole, plug-in type with blade-style terminals and "ON" and "OFF" flag indicators.
  2. Miniature relay contacts shall be silver nickel and have 7 A or 10 A, DPDT or 4PDT ratings. Coil voltages shall be as shown on drawings.
  3. Miniature relays shall have an electrical schematic on the faceplate and a clear cover for visual inspection.
  4. Miniature relays shall have LED status indicators and push-to-test button with incorporated manual override lever.
- D. Relays – Industrial Type
1. Industrial-type relays shall be ruggedly constructed (10 million operation mechanical life), 2-pole or 4-pole, 8-pole, 12-pole, configured NO or NC as shown on drawings, and panel, strip, or DIN rail mounted.
  2. Industrial-type relays shall be finger-safe.
  3. Industrial-type relay contacts shall be silver nickel with a double-break and bifurcated design and 10A, A600 rating for ac.
  4. Accessories shall include adder decks, time delay, latching, surge suppressors and/or mounting strip.
- E. Relays – Voltage Monitoring
1. Relays shall be ruggedly constructed (10 million operation mechanical life) and shall be DIN rail mounted.
  2. Protective functions shall include undervoltage, overvoltage, phase imbalance, phase loss, and phase reversal. Unit shall be capable of automatic and manual reset and shall have LED indication.
  3. Phase imbalance, undervoltage and time dial shall be adjustable.
  4. Relay shall be self-powered, connected to load side with input fuses.
  5. Output contacts shall DPDT, 10 amp at 120 Vac, B300 pilot duty.



F. Relays - Duplex Alternator Relay

1. Relays shall be ruggedly constructed (10 million operation mechanical life) and shall be tube-base/Octal 8-pin relay socket.
2. Detects input of float switch inputs and determines outputs to turn on with line voltage. As the lead and load switches open, the loads remain energized. When all switches open both loads de-energize simultaneously and the lead load alternates.
3. Output contacts shall be SPDT 5 A at 120 Vac.
4. LED indication shown output position.

G. Timers – Solid-State

1. Solid-state timers shall be DIN rail-mounted.
2. The solid-state timer contacts shall be available as SPDT or DPDT, 8 amp.
3. Solid-state timers shall be available with On-Delay, Off-Delay, On-Delay and Off-Delay, One-Shot, and Flasher operating modes as required on the drawings.
4. Solid-state timers shall have coil surge protection and adjustable timing ranges of 0.05 sec to 60 hours as shown on drawings.

H. Timers – Programmable

1. Programmable timers shall be digital timing relays with LCD display and shall be socket or panel mounted.
2. Programmable timer contacts shall be SPDT, rated 5 A, B300.
3. Programmable timer panel surface shall offer Type 4X/IP66 protection.
4. Programmable timers shall be configurable for "SIGNAL ON-DELAY", "POWER ON-DELAY", "OFF-DELAY", "REPEAT CYCLE", "ONE-SHOT", and "CUMMULATIVE" operating modes as required on the drawings.
5. Programmable timers shall have timing ranges of 0.000 sec. to 9999 hours depending on selected mode and as shown on drawings.

## 2.5 MINIATURE CIRCUIT BREAKERS

A. Miniature circuit breakers shall be thermal-magnetic, current-limiting type, sized as specified on the drawings:

1. 0.5-63 A current rating
2. 1-pole, 2-pole, or 3-pole
3. Type C or Type D tripping characteristic

B. Miniature circuit breakers shall be UL Listed.

C. Miniature circuit breakers shall be rated for:

1. Voltage: Maximum 480Y/277 Vac (UL/CSA)
2. Interrupting capacity: 10 A (UL/CSA)

D. Housing shall satisfy Insulation Group II/RAL 7035, shall have IP20 finger-safe design, shall be suitable for DIN rail mounting and shall include status indicator window and scratch- and solvent-resistant printing.

E. Miniature circuit breakers shall support reversible line and load connections and shall have dual terminals that:

1. Connect up to 4 wires, or 2 wires and a bus bar.
  2. Clamp from both sides.
  3. Have a unique design that directs wires into openings to prevent wiring misses.
- F. Miniature circuit breakers shall be compatible with UL 508 Listed bus bars, auxiliary contacts, signal contacts, shunt trips and toggle-mount lockout attachments.

## 2.6 TERMINAL BLOCKS AND FUSE BLOCKS

- A. Terminal Blocks: Control, No. 22 to No. 8 AWG
1. Control terminal blocks shall be screw-type, feed-through.
  2. Nickel-Plated terminals and stainless steel screws.
  3. Control terminal blocks shall be certified:
    - a. UR/CSA: No. 22 to No. 8 AWG wire range, 50 A maximum current, 600 Vac/Vdc rating
  4. Control terminal blocks shall have a snap-in card marking system.
- B. Terminal Blocks – Power
1. Power terminal blocks shall be one of the following styles:
    - a. Mini-block: 3-pole, rated at 600 Vac/Vdc, 115 A
    - b. Open-style power distribution block with copper connectors: 3-pole or 1-pole, rated at 600 Vac/Vdc, 175-760A
    - c. Open-style feed-through/splicer terminal block with copper connectors: 3-pole or 1-pole, rated at 600 Vac/Vdc, 175-760 A
  2. Power terminal blocks shall be certified by UR, CSA, and CE.
  3. Wire ranges and tightening torques shall be labeled on the block.
  4. Power terminal blocks shall have a write-on marking surface or marker retention feature.
- C. Fuse Blocks
1. Fuse block kits shall be used for protection of transformers and control circuits capable of delivering no more than 200,000 RMS symmetrical Amps, 600 V maximum.
  2. Fuse block kits shall be 1-pole, 2-pole or 3-pole.
  3. Each pole shall have a fuse cover.

## 2.7 PANEL MOUNT SIGNALING ALARM

- A. Combined Sounder and LED Beacon
1. The combined sounder and flashing LED beacon shall have polycarbonate housing and lens, 45 mm size, 22 mm mounting hole, and Type 4/4X/13, IP65/IP66 ingress rating as required on the drawings.
  2. Control logic shall be provided so that the unit can be silenced until the alarm is cleared and reset.
  3. The sounder shall have an average of 103 dBA at 1 m and shall be configured as pulsing.

## 2.8 CURRENT LOOP SIGNAL SURGE PROTECTOR

- A. Signal conditioner/isolator shall be provided for each analog input/output signal leaving panel.
  - 1. High-density device: 6 mm wide, current/voltage isolator
- B. The signal conditioner/isolator shall mount on DIN rail and provide local status indications

## 2.9 ENCLOSURE BREATHER/DRAIN

- A. Provide enclosure breather/drain on all wall or switchrack mounted enclosures mounted outdoors or indoors in non-air-conditioned rooms. Breather/Drain shall be Type 316 Stainless, 3/4-inch size and shall not violate NEMA rating of enclosure. Breather/Drain shall be similar Crouse-Hinds, ACD Series.

## 2.10 TEMPERATURE CONTROL

- A. Provide thermostatic controlled heaters on all panels mounted outdoors or as indicated on the drawings. Heating element shall be Positive Temperature Coefficient (PTC). Heaters shall be sized to protect equipment for low temperatures, condensation, and corrosion.

## 2.11 POWER SUPPLIES

- A. Control Power Transformer
  - 1. The control power transformer shall be epoxy encapsulated 120 V secondary and shall offer finger-safe protection. Control transformer shall be UL 5085 listed.
  - 2. The control transformer shall have dual primary and secondary fuses.
  - 3. The control transformer shall have sufficient capacity to operator integral device, remotely located pilot, indicating, control devices, motor winding heater and panel heater.
  - 4. The control transformer shall be sized with a 200 VA spare capacity.
- B. 24 Vdc Power Supplies
  - 1. 24 Vdc power supplies shall be switched, DIN rail mounted, screw terminals, temperature range of minus 0 to plus 60 degrees C.
  - 2. 24 Vdc power supplies shall have low inrush current and shall incorporate a minimum 120% Power Burst design.

## PART 3 - EXECUTION

### 3.1 DELIVERY, STORAGE AND HANDLING

- A. The supplier shall coordinate the shipping of equipment.
- B. The supplier shall store the equipment in a clean and dry space.
- C. The supplier shall protect the devices from dirt, water, construction debris, and traffic.

### 3.2 INSTALLATION

- A. The supplier shall verify all settings have been properly adjusted prior to energizing.
- B. The supplier shall ensure accessibility to electrical control devices.

### 3.3 OPERATOR CONTROL STATIONS

- A. Permitted uses of NEMA 4/13 Enclosure:
  - 1. Indoor spaces that are dry, ventilated, or air-conditioned spaces.
- B. Permitted uses of NEMA 4X 316 SS Enclosure:
  - 1. All outdoor spaces.
  - 2. Indoor spaces that are damp, wet, or in chemical areas.

**END OF SECTION**

**SECTION 26 29 13  
ENCLOSED CONTROLLERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.
  - 2. Full-voltage magnetic.
  - 3. Reduced-voltage solid state.
  - 4. Multispeed.

**1.2 REFERENCES**

- A. Definitions
  - 1. CPT: Control power transformer.
  - 2. MCCB: Molded-case circuit breaker.
  - 3. MCP: Motor circuit protector.
  - 4. N.C.: Normally closed.
  - 5. N.O.: Normally open.
  - 6. OCPD: Overcurrent protective device.
  - 7. SCR: Silicon-controlled rectifier.

**1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

**1.4 SUBMITTALS**

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
    - e. Listed and labeled for integrated short-circuit current (withstand) rating of

OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

- f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
2. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  1. Routine maintenance requirements for enclosed controllers and installed components.
  2. manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  3. Manufacturer's written instructions for setting field-adjustable overload relays.
  4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- F. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

#### 1.5 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 NFPA 70.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; connect factory-installed space heaters to temporary electrical service.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  1. Ambient Temperature: Not less than minus 22°F and not exceeding 120°F.
  2. Altitude: Not exceeding 6,600 feet.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10% of quantity installed for each size and type, but no fewer than 6 of each size and type.
  - 2. Control Power Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than 6 of each size and type.
  - 3. Indicating Lights: S-x of each type and color installed.
  - 4. Auxiliary Contacts: Furnish 2 spares for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish 3 spares for each size and type of magnetic contactor installed.

## PART 2 - PRODUCTS

### 2.1 FULL-VOLTAGE CONTROLLERS

- A. Manufacturer: Subject to compliance with the requirements of this Section, provide products by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Square D; Schneider Electric.
  - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
- B. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- C. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  - 1. Configuration: Non-reversing and Two speed.
  - 2. Surface mounting.
  - 3. Red pilot light.
  - 4. Additional Nameplates: "HIGH" and "LOW" for two-speed switches.
- D. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  - 1. Configuration: Non-reversing and Two speed.
  - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  - 3. Surface mounting.
  - 4. Red pilot light.
  - 5. Additional Nameplates: "HIGH" and "LOW" for two-speed controllers.
- E. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Non-reversing and Two speed.
  2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
  3. Surface mounting.
  4. Red pilot light.
  5. Additional Nameplates: "HIGH" and "LOW" for two-speed controllers.
  6. Normally Open auxiliary contact.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. Normally Open alarm contact that operates only when MCP has tripped.
  2. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA. Configuration: Non-reversing.
  3. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  5. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  6. NC isolated overload alarm contact.
  7. External overload reset push button.

## 2.2 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
1. Eaton Corporation; Cutler-Hammer Products.
  2. General Electric Company; GE Industrial Systems.
  3. Square D; Schneider Electric.



4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
- B. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
- C. Combination Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  1. Configuration: Standard duty; nonreversible.
  2. Starting Mode: Voltage ramping Current limit Torque control Torque control with voltage boost; field selectable.
  3. Stopping Mode: Coast to stop Adjustable torque deceleration Adjustable braking; field selectable.
  4. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode. Contactor shall be NEMA-rated for full cross-the-line starting.
  5. Shorting and Input Isolation Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.
  6. Logic Board: Identical for all ampere ratings and voltage classes with environmental protective coating.
  7. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400% current limitation for 20 sec.
  8. SCR bridge shall consist of at least two SCRs per phase and will provide stable and smooth acceleration with external feedback from the motor or driven equipment.
  9. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    - a. Adjusting motor full-load amperes as a percentage of the controller's rating.
    - b. Adjusting current limitation on starting as a percentage of the motor full-load current rating.
    - c. Adjusting linear acceleration and deceleration ramps, in seconds.
    - d. Initial torque as a percentage of the nominal motor torque.
    - e. Adjusting torque limit as a percentage of the nominal motor torque.
    - f. Adjusting maximum start time, in seconds.
    - g. Adjusting voltage boost as a percentage of the nominal supply voltage.
    - h. Selecting stopping mode and adjusting parameters.
    - i. Selecting motor thermal overload protection class between 5 and 30.
    - j. Activating and de-activating protection modes.
    - k. Selecting or activating communication modes.
  10. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
    - a. Controller Condition: Ready, starting, running, stopping.

- b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
  - c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
11. Controller Diagnostics and Protection:
- a. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  - b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
  - c. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
  - d. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
12. Remote Output Features:
- a. All outputs prewired to terminal blocks.
  - b. Form C status contacts that change state when controller is running.
  - c. Form C alarm contacts that change state when a fault condition occurs.
13. Optional Features:
- a. Additional field-assignable Form C contacts, as indicated, for alarm outputs.
  - b. Surge suppressors in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
  - c. Full-voltage bypass contactor operating automatically. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
  - d. Solid-State Overload Relay:
    - 1) Switch or dial selectable for motor running overload protection.
    - 2) Sensors in each phase.
    - 3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  - e. NC, isolated overload alarm contact.
  - f. External overload reset push button.
14. MCP Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - b. Lockable Handle: Accepts 3 padlocks and interlocks with cover in closed position.

- c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
- d. NO alarm contact that operates only when MCP has tripped.
- e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

### 2.3 MULTISPEED MAGNETIC CONTROLLERS

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. General Electric Company; GE Industrial Systems.
  - 3. Square D; Schneider Electric.
  - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
- B. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- C. Combination Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.
  - 1. Configuration: Nonreversing; 2 winding.
  - 2. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - 3. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 4. Compelling relays shall ensure that motor will start only at low speed.
  - 5. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
  - 6. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
  - 7. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
  - 8. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - e. NO, isolated overload alarm contact.
    - f. External overload reset push button.
  - 9. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

- b. Lockable Handle: Accepts 3 padlocks and interlocks with cover in closed position.
- c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
- d. NO alarm contact that operates only when MCP has tripped.
- e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

## 2.4 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  - 1. Dry and Clean Indoor Locations: Type 12.
  - 2. Outdoor Locations: Type 4X Type 316 stainless steel, with fast-operating clamp-cover junction box clamp, Type 316 stainless steel.
  - 3. Other Wet or Damp Indoor Locations: Type 4X Type 316 stainless steel, with fast-operating clamp-cover junction box clamp, Type 316 stainless steel.
  - 4. Hazardous Areas Indicated on Drawings: Type 7.

## 2.5 ELECTRICAL CONTROL DEVICES

- A. Pilot devices, relays, terminal blocks and other auxiliary equipment shown on control schematics, complying with Division 26 Section 26 29 03 "Low-Voltage Pilot Control Devices."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section 26 05 29 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 3 Section "Cast-in- Place Concrete (Limited Applications)."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through

concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
  - D. Install fuses in control circuits if not factory installed.
  - E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
  - F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
  - G. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
  - H. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved nameplate.
  3. Label each enclosure-mounted control and pilot device.

### 3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and central control system. Comply with requirements in Division 26 Section 26 95 19 "Low-Voltage Electric Power conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low-pressure and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to assist in testing and to inspect components, assemblies, and equipment installations, including connections.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at controller locations are within plus or minus 10% of motor nameplate rated voltages. If outside this range for any motor, OWNER 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
  - 7. NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 8. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 9. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 10. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify OWNER's Representative before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

### 3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

**END OF SECTION**

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**SECTION 26 29 23**  
**LOW-VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for adjustable or variable frequency motor controllers (also identified as VFDs, AFDs, Variable Frequency Drives, or Adjustable Frequency Drives) as required for the complete performance of the Work, as shown on the Drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.
- B. Related Sections include, but shall not be limited to, the following:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections, apply to this Section.
  - 3. Refer to the specification sections for the VFD driven equipment for additional requirements.

**1.2 REFERENCES**

- A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
  - 1. American Society of Civil Engineers (ASCE)
    - a. ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures."
  - 2. Institute of Electrical and Electronics Engineers (IEEE)
    - a. IEEE 519, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"
  - 3. International Code Council (ICC):
    - a. ICC IBC, "International Building Code"
    - b. ICC UBC, "Uniform Building Code"
    - c. AC156, "Acceptance criteria for Seismic Certification by Shake Table Testing of Nonstructural Components"
  - 4. International Electrotechnical Commission (IEC)
    - a. IEC 61000, "Electromagnetic Compatibility"
    - b. IEC 61800-5-1, "Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy"
    - c. IEC 60068 Part 2-3, "Basis Environmental Testing Procedures Part 2: Tests – Test Ca: Damp Heat"
    - d. IEC 60146-1-1, "Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements"

- e. IEC 60664-1, "Insulation Coordination for Equipment Within Low-Voltage Systems"
  - f. IEC 60447, "Basic and safety principles for man-machine interface, marking and identification - Actuating principles"
  - g. IEC 61439-1, "Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules"
  - h. IEC 60364-1, "Low-Voltage Electrical Installations - Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions"
  - i. IEC 60204-1, "Safety of machinery - Electrical equipment of machines - Part 1: General requirements"
  - j. IEC 106, "Guide for Specifying Environmental Conditions for Equipment Performance Rating"
  - k. IEC 529, "Degrees of protection provided by enclosure"
  - l. IEC 1000, "Electromagnetic Compatibility"
  - m. IEC 1800, "Adjustable speed Electrical power drive systems"
  - n. IEC 60721-3-3, "Classification of Environmental Conditions"
  - o. IEC 60255-8, "Overload Relays"
  - p. IEC 60801-2,-3,-4,-5, "Immunity Tests"
  - q. IEC 60947-2, "Low-voltage switchgear and controlgear - Part 2: Circuit-breakers"
5. International Organization for Standardization (ISO):
    - a. ISO 9001, "Quality Management Systems – Requirements "
    - b. ISO 14001, "Environmental management systems -- Requirements with guidance for use"
  6. National Electrical Manufacture Association (NEMA)
    - a. NEMA 250, "Enclosures for Electrical Equipment"
    - b. NEMA ICS Part 4, "Overload Relays"
    - c. NEMA ICS7, "Industrial Control and Systems Adjustable Speed Drives"
    - d. NEMA ICS 7.1, "Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives"
  7. National Fire Protection Association
    - a. NFPA 70, "National Electrical Code (NEC)"
    - b. NFPA 79, "Electrical Standard for Industrial Machinery"
    - c. NFPA 5000, "Building Construction and Safety Code"
  8. Occupational Health and Safety Administration (OHSA)
    - a. OSHA 1910.95, "AC Drive Controller Acoustical Noise"
  9. Underwriters Laboratories, Inc. (UL):
    - a. UL 50, "Enclosures for Electrical Equipment"
    - b. UL 98, "Disconnect Switches"
    - c. UL 507, "Electric Fans"
    - d. UL 508, "Industrial Control Equipment"
    - e. UL 508A, "Standard for Industrial Control Panels"

- f. UL 991, "Safety Tests for Safety Related Controls Employing Solid State Devices"
- g. UL 508C, UL 61800-5-1, "UL Standard for Safety Power Conversion Equipment"

### 1.3 DEFINITIONS

- A. General, Definitions: Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
  - 1. LV: Low voltage
  - 2. VFD: Variable frequency drive
  - 3. VSI: Voltage source inverter
  - 4. AFE: Active front end
  - 5. DFE: Diode front end
  - 6. MTBF: Mean time between failure
  - 7. MTTR: Mean time to repair
  - 8. NPC: Neutral point clamped
  - 9. IGBT: Insulated gate bipolar transistor
  - 10. PWM: Pulse width modulation

### 1.4 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittals and Section 26 00 00 Electrical Requirements, in addition to those specified herein.
  - 1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
  - 2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
  - 3. Submit required product data and shop drawings specific to each product and accessory proposed. In addition, include the following information:
    - a. Manufacturer, supplier, and proposal specific contact information.
    - b. Manufacturer's catalog data indicating model numbers, equipment specifications and construction features including all furnished options, and accessories.
    - c. VFD assembly rated input KVA and output KVA, percent efficiency, operating characteristics, and electrical characteristics.
    - d. Maximum Btu heat release data and ambient cooling requirements.
    - e. Enclosure type, NEMA rating, material and finishes.
    - f. Certification of UL conformity
    - g. Equipment assembly. Indicate dimensions, shipping section dimensions,

- weights, foundation requirements, required clearances, location and size of each field connection, and mounting and installation instructions.
- h. Include elementary and interconnection diagrams for power, signal, control, and communications wiring. Diagrams shall provide the minimum detail as shown for drawings in the appendix of NFPA 79. All field terminals shall be identified and updated later within the O&M data to include actual field connection information. Drawings shall not be typical, but be provided for each VFD furnished.
  - i. Electronic 2D dimensional drawing and 3D model CAD files for standard units shall be provided upon request if not available from the manufacturer's website.
- B. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which, the following items are shown and coordinated with each other, using input from installers of the items involved:
- 1. Required working clearances and required area above and around VFDs.
  - 2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.
  - 3. Show support locations, type of support, and weight on each support.
  - 4. Indicate field measurements.
- C. Harmonic Analysis Report: Provide project-specific calculations and manufacturer's statement of compliance with IEEE 519, latest revision. Owner shall supply detailed electrical power system characteristics to support harmonic calculations.
- D. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section 01 78 23 Operation and Maintenance Data, Section 26 00 00 Electrical Requirements and additional requirements specified herein.
- 1. Submit required Operations & Maintenance data specific to each product and accessory proposed. In addition, include the following information:
    - a. Manufacturer, supplier, support, and repair center specific contact information.
    - b. Manufacturer's standard operation and maintenance data assembled for each size and type of equipment furnished.
    - c. All construction, installation, schematic, and wiring diagrams updated to an as-installed and commissioned state.
    - d. All configured settings/parameters for adjustable components updated to an as-installed and commissioned state if different from the factory default. Electronic copies of configuration files shall be provided, on media acceptable to the Owner (e.g. CD, USB stick, etc.), where these configurations can be saved as an electronic file for future upload into replaced or repaired components.
    - e. List of furnished and recommended spare parts.
    - f. Statement of standard Warranty.
  - 2. O&M manuals shall be submitted prior to arrival of equipment on site.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of

specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
  2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.
  3. The VFD manufacturer shall have the Environment Certification ISO 14001 for EcoDesign.
- B. Installer Qualifications: Installer shall be a firm that shall have a minimum of 10 years of successful installation experience with projects utilizing equipment similar in type and scope to that required for this Project and shall be approved by the manufacturer's representative.
- C. All work performed, and all materials used shall be in accordance with the National Electrical Code and with applicable local regulations and ordinances. Equipment assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

#### 1.7 WARRANTY

- A. General: Refer to Section 01 77 00 - Closeout Procedures.
- B. The manufacturer shall warrant products against defects in material and workmanship for 24 months from the date of commissioning or 36 months from the date of shipment, whichever comes first, provided that the manufacturer performs functional testing, commissioning and first parameter adjusting of equipment. During the warranty period the manufacturer shall repair or replace defective products. This warranty shall be in addition to any provided by the Contractor. The warranty shall exclude normal wear and tear under normal usage and any damage caused by abuse, modification, or improper maintenance by entities other than the manufacturer or its approved representative.
- C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the

Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

## 1.8 SPECIAL TOOLS AND SPARE PARTS

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
  - 1. Contact information for the closest parts stocking location to the Owner.
  - 2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
  - 3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the VFD equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- B. A replacement VFD shall be provided for each type and size installed between 1-125 HP 460V in lieu of replacement components. Spare parts shall be provided for each type and size of VFD furnished greater than 125 HP 460V. Provide at least one complete set of all plug-in replaceable components of each size and type used. At a minimum the following shall be provided:
  - 1. Power and control fuses
  - 2. Non-LED type indicating lights
  - 3. Rectifier power semiconductors
  - 4. Inverter power semiconductors
  - 5. One of each type of printed circuit board and gate firing board
  - 6. Other field replaceable components
- C. Any manufacturer specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished. At a minimum the following shall be provided:
  - 1. PC-based and Android tablet configuration software tool.
  - 2. Electronic configuration files, in a media format acceptable by the Owner (e.g. CD, USB stick, etc.), updated to an as-installed and commissioned state.
- D. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Products: VFDs specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:
  - 1. Allen Bradley

2. Danfoss
  3. Eaton
  4. GE/ABB
  5. Siemens
  6. Square D
  7. WEG
- B. The VFD manufacturer shall provide for repair and service of the drive components with worldwide support. The VFD manufacturer shall provide remote diagnostic services in conjunction with the VFD's user interface to provide QR code, or equivalent, linked access to worldwide web based enhanced diagnostics, documentation, and customer service.

## 2.2 GENERAL REQUIREMENTS

- A. The VFDs shall be built to comply with the UL standard and shall be marked in accordance with to UL 508, UL508C or UL 61800-5-1.
- B. Without limiting the generality of other requirements of this Section, all work specified herein shall conform to or exceed the applicable requirements of the standards below, provided, that wherever the provisions of listed publications conflict with the requirements specified herein, the more stringent requirements shall apply:
1. ANSI/NFPA 70: National Electrical Code
  2. EN61800-5: Electronic equipment for use in power installation
  3. CSA C22.2 No. 274 – Adjustable Speed Drives
  4. IEC 60068 Part 2-3: Basis Environmental Testing Procedures Part 2: Tests – Test Ca: Damp Heat
  5. IEC 60146-1-1: Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements
  6. IEC 60664-1: Insulation Coordination for Equipment Within Low-Voltage Systems
  7. IEC 60447: Basic and safety principles for man-machine interface, marking and identification - Actuating principles
  8. IEC 61439-1: Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules
  9. IEC 60364-1: Low-Voltage Electrical Installations - Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions
  10. IEC 60204-1: Safety of machinery - Electrical equipment of machines - Part 1: General requirements
  11. IEC 106: Guide for Specifying Environmental Conditions for Equipment Performance Rating
  12. IEC 529: Degrees of protection provided by enclosure
  13. IEC 1000: Electromagnetic Compatibility
  14. IEC 1800: Adjustable speed Electrical power drive systems
  15. IEC 60721-3-3: Classification of Environmental Conditions
  16. IEC 60255-8: Overload Relays
  17. IEC 60801-2,-3,-4,-5: Immunity Tests

18. NEMA ICS Part 4: Overload Relays
  19. NEMA ICS7: Industrial Control and Systems Variable Speed Drives
  20. UL 508C, UL 61800-5-1: UL Standard for Safety Power Conversion Equipment
- C. Variable Frequency Drives (VFDs) shall provide for the starting and speed control of NEMA B, design AC inverter duty asynchronous motors and synchronous motors with permanent magnets by the adjustment of output voltage and frequency. The VFD shall be a digitally controlled drive, using Pulse Width Modulation (PWM).
- D. Unless otherwise specified or shown within the Contract Documents, the Contractor shall be responsible for matching the VFD to the load (variable or constant torque) as well as the speed and current of the actual motor being controlled. This sizing shall match the KVA and inrush characteristics of the motors provided.
- E. The VFD manufacturer shall design the device with more than 70% of recyclability rate. The VFD shall be compliant with the "Green" Premium label (REACH, RoHS-2, EOL, and PEP). The VFD Manufacturer shall design the device according to the IEC 62635 guidelines to reduce the carbon footprint. The materials used in the VFD shall be recyclable, non-toxic and flame retardant. The VFD manufacturer shall provide the carbon footprint of the devices.
- F. Environmental Requirements
1. The VFD shall be rated to withstand the following environmental conditions while able to give a 100% output current continuously. Where derating is necessary to meet on site environmental conditions, the manufacturer shall submit the VFDs derated performance. The derating factor shall be specified so that neither the lifetime of the VFD nor the unit's performance, overload capability included, nor the reliability of the VFD shall suffer.
    - a. Storage Temperature: -40°C to 70°C,
    - b. Operating Temperature for UL Type 1 VFDs: -15°C to 50°C without derating, up to 60°C with derating of power stage (UL Type 1)
    - c. Operating Temperature for enclosed VFDs: -10°C to 40°C without derating, down to -10°C with enclosure heater, up to 55°C with derating of power stage
    - d. Relative Humidity: ≤95% relative humidity without condensation per IEC 60068-2-3
    - e. Operating Altitude: ≤1000m without derating, up to 4800m with derating.
    - f. Corrosion Protection Level: Class 3C3 according to IEC 60721-3-3 for cooling air and chemical gases
    - g. Biological Protection Level: Class 3B1 according to IEC 60721-3-3
    - h. Dust Protection Level: Class 3S3 according to IEC 60721-3-3
    - i. Vibration and Shock Protection Level: Class 3M3 according to IEC 60721-3-3
  2. The VFDs shall have an integral enclosure that shall protect from ingress of dirt and water in accordance with [UL Type 12 or as shown on drawings]. The user interface terminal shall be rated UL Type 12, mounted on front face of enclosure, and accessible for programming and controls with the main door closed.
  3. VFD enclosures shall be front cabinet accessible and constructed in conformance with IEC 60439-1. Conduit entry shall be bottom entry as standard to allow for top mounted cooling components. The VFD enclosure shall have a forced air and heat sink



cooling system that does not require liquid or air condition cooling components for ambient temperatures within the drives stated ambient temperature operating range.

## 2.3 PERFORMANCE REQUIREMENTS

- A. The VFD shall be rated for the nominal input voltage specified or shown on the drawings. The VFD shall have a three-phase input voltage tolerance within the following range of the corresponding nominal input voltage:
  - 1. 200V -15% 240V +10%
  - 2. 380V -15% 480V +10%
  - 3. 500 to 690V -15% / +10%
- B. The VFD shall meet the following minimum operating requirements:
  - 1. Rated Frequency: 50 Hz -5% to 60 Hz + 5%.
  - 2. Displacement Power Factor:  $\geq 0.97$
  - 3. Efficiency:
    - a.  $>98\%$  at nominal load for VFD (IP 21 / UL Type 1)
    - b.  $>97.5\%$  at nominal load for enclosed VFD systems.
    - c.  $>96\%$  at nominal load for low harmonic VFD (IP 21 / UL Type 1)
    - d.  $>95.5\%$  at nominal load for low harmonic enclosed VFD systems.
  - 4. Overload Capability: Normal duty at 110% nominal current for 1 min
  - 5. Harmonics Mitigation:  $<48\%$  THDi according to IEC/EN 61000-3-12 at 80-100% load
  - 6. Surge immunity according to IEC/EN 61000-4-5 Level 3
- C. The VFD shall provide a speed range in the motor quadrant 1:100 in sensor less vector control and in the generator quadrant 1:50 in sensor less vector control.
- D. The VFD shall provide an over torque capability better than 110% of the rated motor torque for normal duty applications during 60s, every 10 minutes.
- E. The VFD shall provide a speed accuracy  $\pm 10\%$  of the nominal slip of the motor in sensor less vector control
- F. The VFD shall provide a torque control accuracy  $\pm 15\%$  in sensor less vector control for AC motors
- G. VFD shall meet or exceed the following harmonic limits at the point of common coupling (PCC) for any combination of the pumps and equipment operated from 10-100% speeds under actual operating conditions:
  - 1. Point of Common Coupling (PCC) Location: Motor Control Center bus, which feeds the VFD.
  - 2. Voltage: 5% total harmonic distortion (THD) per IEEE 519
  - 3. Current: limits for  $20 < I_{sc}/I_L < 5$  per IEEE 5192
- H. VFD manufacturer shall insure the VFD will not:
  - 1. Have any detrimental effect on the pump station power system.
  - 2. Have any detrimental effect on any communications system including telephone and SCADA systems.

3. Produce crosstalk between VFD's.
  4. Produce any electrical resonance problems.
  5. Produce any torsional resonance problems.
  6. Torque pulsations shall not exceed 30% of the motor or pump shaft rated torque.
- I. If harmonic filters are required to meet these requirements, the VFD manufacturer must provide the filters at no extra cost and is responsible for the design, manufacturing, and installation of the filter. Compliance shall be verified with on-site field measurements of the harmonic distortion at the point of common coupling with and without the VFD operating.
  - J. VFD system shall maintain a 0.95 minimum power factor from 10-100% speed. VFD system, including power factor correction and/or harmonic filter, shall never have a leading power factor under operation or at any other time. VFD manufacturer is to supply a power factor correction system, if required, to meet this requirement. The power factor correction capacitors shall be mounted on the input side of the VFD.
  - K. It is the responsibility of the VFD supplier to obtain source impedance and other circuit data from the utility prior to bidding.

#### 2.4 APPLICATION REQUIREMENTS

- A. The VFD shall be able to control motors using the following motor control types in accordance with the applications needs and energy savings: Volts per hertz VC Standard.
- B. The VFD shall provide a Real Time Clock management with battery backup.
- C. The VFD shall be capable of automatic tuning of motor parameters through measurement of the motor without rotation, and without the need to disconnect the load from the motor.
- D. The VFD shall provide functionality adjustable within the drive parameters to reduce voltage surges on motor cables.
- E. The Contractor shall provide AC chokes and filters to fit installation and motor requirements per the following guidelines:
  1. Voltage reflection suppression for motors compliant to IEC60034-25 or NEMA MG1 Part 31
    - a. Unshielded motor cable length up to 500 feet (150 meters) shall be managed with the VFD functionality
    - b. Unshielded motor cable length up to 1000 feet (300 meters) an AC choke shall be required
    - c. Unshielded motor cable length up to 1640 feet (500 meters) a dV/dt filter shall be required
    - d. Unshielded motor cable length up to 3280 feet (1000 meters) a Sinus filter shall be required
  2. Voltage reflection suppression with motors not compliant to IEC60034-25 or NEMA MG1 Part 31
    - a. Unshielded motor cable length up to 50 meters a dV/dt filter shall be required
    - b. Unshielded motor cable length up to 1000 meters a Sinus filter shall be required
- F. Protection

1. The VFD shall be UL 508 or UL61800-5-1 listed for use on distribution systems.
2. The VFD shall have coordinated short circuit rating designed to UL 508C or UL 61800-5-1 and NEMA ICS 7.1 Short Circuit Rating 65 kAIC
3. Micro-short voltage sag immunity per SEMI F47.
4. Upon power-up the VFD shall automatically test for valid operation of memory, option module, loss of analogue reference input, loss of communication, DC to DC power supply, control power and the pre-charge circuit.
5. The VFD shall be protected against short circuits, between output phases and ground and the logic and analogue outputs.
6. The VFD shall have a selectable ride through function that shall allow the logic to maintain control for a minimum of one second without tripping.
7. The deceleration mode of the VFD shall be programmable for normal and trip conditions. The stop modes shall include freewheel stop, fast stop.
8. Upon loss of the analog process follower reference signal, the VFD shall trip and/or operate at a user-defined speed set by a software programmed speed settings or last speed.
9. The VFD shall integrate a protection against IGBT and heat sink over temperature.
10. The VFD shall have solid state thermal protection that is UL Listed and meets UL 508C as a Class 10 overload protection and meets IEC 60947-2.
11. The VFD shall have a motor thermal memory retention function per UL requirements.
12. The VFD shall be able to protect the motor when temperature probes are connected.
13. The VFD shall be able to limit the motor surge (  $I dv/dt$  ) at twice the DC bus voltage
14. The VFD shall provide IGBT protection
  - a. IGBT overcurrent protection
  - b. IGBT checkup sequence
  - c. IGBT checkup sequence before PWM enable sequence
  - d. IGBT over-heat protection
15. The VFD shall provide VFD Current protection
  - a. Phase short circuit protection
  - b. Ground protection
  - c. Over-current protection
16. The VFD shall provide VFD Voltage error protection
  - a. Mains over-voltage protection
  - b. Mains under-voltage protection
  - c. DC Bus over-voltage protection
  - d. DC Bus pre-charge protection
17. The VFD shall provide VFD Thermal protection
  - a. VFD over-temperature protection
  - b. FAN management
  - c. Switching Frequency management
18. The VFD shall provide internal error detection.

19. The VFD shall provide Motor protection functions
  - a. Motor output phase detection
  - b. Motor surge voltage
  - c. Motor over load detection
  - d. Motor stall protection
20. The VFD shall provide Application protection functions
  - a. Catch on fly function
  - b. Mains input phase lost protection
  - c. Motor over-speed input protection
  - d. Current limitation
  - e. Power limitation
  - f. Reverse inhibition
  - g. Under-load protection
  - h. Over-load protection
  - i. External error management
  - j. Loss of follower signal
  - k. Thermal Sensor management
  - l. PID Feedback
  - m. Customer defined input

## 2.5 CONTROL AND INTERFACE REQUIREMENTS

### A. Indicators

1. The VFD shall display a signal by LED near the connection point of the device when a hazardous voltage is present.
2. The VFD shall have 3 LEDs for local diagnostics.
3. The VFD shall have 3 dual color LEDs for embedded communication status.
4. The VFD shall have 4 dual color LEDs for optional communication status

### B. User Interface

1. A detachable UL Type 12/IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel shall be provided for monitoring, annunciation, and configuration. The graphical display shall change to a red backlit color when an alarm occurs. The door mounting for the user interface shall be done with a 22 mm hole.
2. A "Simply Start "menu for fast and easy commissioning shall be provided and parameter setting shall be easily accessible and user friendly with plain text messaging and actual setting range.
3. The keypad shall be capable of providing password protection.
4. The user interface shall be capable of saving and downloading configurations of the VFDs, as well as porting them to other VFDs.
5. The user interface shall offer a Mini-USB port for mass storage or PC device connection.
6. The mechanical mounting for the user interface on the cabinet shall be done with a 22

mm hole.

7. The VFD shall have self-diagnostic capabilities to display alarms, errors, and warnings as they occur and be able to store at least 15 last messages into the memory. These shall be accessible by PC maintenance tools or web server with flash record for data logging expertise
8. The user interface shall be identical throughout the power range to avoid confusion amongst the users and need for training in several different units.
9. The displayed messages shall be in plain text English.

C. Control Interface:

1. VFD shall interface with automation systems to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory.
2. The speed command and reference may come from different control sources:
  - a. I/O terminals
  - b. Communication network
  - c. Web server
  - d. Remote graphic display terminal
3. A minimum of the following standard inputs / outputs shall be provided to interface with control systems and instrumentation:
  - a. Analog Inputs: 3 programmable 0(4)-20 mA or 0-10 vdc
    - 1) 2 analog inputs shall also be programmable for temperature sensors (PTC, PT100, PT1000, KTY84)
  - b. Analog Outputs: 2 programmable 0(4)-20 mA or 0-10 vdc
  - c. Discrete Inputs: 6 programmable isolated logic inputs as either sink or source
    - 1) 2 discrete inputs shall also be programmable as 0-30 kHz pulse inputs
    - 2) 2 discrete inputs shall be dedicated Safe Torque Off safety function in accordance with IEC/EN 61508-1 SIL3
  - d. Discrete Outputs: 6 programmable relay contacts
    - 1) 1 discrete output shall be dedicated to product watchdog logic
4. Programmable analog inputs shall be able to be assigned the following parameters:
  - a. Speed reference
  - b. Summing reference
  - c. Subtracting reference
  - d. Multiplying reference
  - e. Torque reference
  - f. Torque limitation
  - g. PID feedback
  - h. Manual PID reference
  - i. PID speed reference
  - j. Forced local reference
5. Programmable analog outputs shall be able to be assigned the following parameters:

- a. Motor current
  - b. Motor frequency
  - c. Motor torque (signed or unsigned)
  - d. Motor power
  - e. Motor voltage
  - f. Output frequency (signed or unsigned)
6. Programmable discrete inputs shall be able to be assigned the following parameters:
- a. Run
  - b. Error reset
  - c. Command switching
  - d. External error
  - e. Forced local control
  - f. Forced operation
  - g. Overload detection
  - h. Outlet pressure switch select
  - i. Pipe fill
  - j. Dry running no flow switch select
  - k. Pump low flow no flow switch select
7. Programmable discrete outputs shall be able to be assigned the following parameters:
- a. Ready
  - b. Drive running
  - c. Frequency reference attained
  - d. Drive error
  - e. Alarms: load slipping, 4-20mA loss, brake control, external error, PTC, PID error, PID feedback, IGBT temperature, under voltage, torque control, drive temperature, braking resistor, fan counter, fan feedback, customer warning, power threshold, electrical power drift
  - f. Water warning: dry running, flow, inlet pressure, outlet pressure, pump cycling, anti-jam, outlet pressure switch,
8. Safety Inputs
- a. The VFD shall provide 2 inputs dedicated to Safe Torque Off (STO) safety function, which prohibits unintended equipment operation, in accordance with IEC/EN 61508-1 SIL3.
  - b. The VFD shall be compliant with EN13849 (PL e).
  - c. The VFD shall be compliant with safety of machinery EN 954-1
  - d. The VFD manufacturer shall provide the certified schematics and the list of devices in order to comply with IEC/EN 60204-1 stopping category 0 and 1.
  - e. The VFD shall integrate the safety contacts in compliance with EN-81 13.2.2.3
- D. Communications
- 1. The VFD shall provide at a minimum 1 Modbus and 1 Ethernet Modbus TCP

communications ports. In addition, the following communications options shall be provided as necessary for communications. Refer to communication requirements specified elsewhere within the Contract Documents.

- a. Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain
2. VFD Ethernet ports shall be IPv6 compliant, allow for web server access and provide network management via SNMP and clock synchronization.
3. The VFD shall provide an embedded web server for enhanced diagnostic, mini usb, parameter access, and energy management. There shall be the capability to create a user-defined custom dashboard for viewing drive and process status through tables, charts, and graphical views. It shall be possible to export data in standard table format using the webserver, for information around energy consumption as well as error and warning history.
4. The VFD shall be compliant with the Cyber Security Management ISA Secure /Achilles.
5. VFD communications modules shall be capable of being remotely powered by a separate external 24 VDC to allow for continued communications when the drive power supply is off.
6. The VFD shall provide integration connectivity via
  - a. DHCP protocol for Fast Device Replacement
  - b. DTM library in compliance with standard FDT technology

#### E. Configuration

1. The VFD shall be capable of accepting independent command and speed reference signals from:
  - a. Terminals
  - b. Modbus port
  - c. Ethernet port
  - d. Communication option card
  - e. Keypad display.
2. The VFD shall provide a Speed set-point function capable of:
  - a. Maximum output frequency function
  - b. Low and high speed scaling and limitation function
  - c. Jump frequency
3. The VFD shall provide a Stop function capable of:
  - a. Deceleration ramp on power loss
4. The VFD shall have an acceleration/deceleration, time adjustable ramp function capable of:
  - a. Ramp type: linear ramp, S shape ramp, with U or customized profile.
  - b. Ramp Deceleration adaptation
  - c. Ramp switching
5. Application programming dedicated to pumps
  - a. The VFD shall provide Pump Control & Monitoring Functions
    - 1) Centrifugal pump characteristics and configurations.

- 2) Pump monitoring function to define data relevant for pump (acceleration, low speed, high speed, etc.)
  - 3) Application Units function to define units used in applications
  - 4) Pump Cyclic Start Protection to protect the pump against too many restarts in a dedicated time period.
  - 5) Multi-pump functions.
- b. The VFD shall provide Pump Protection Functions
- 1) Anti-Jam function to remove automatically clogging substances from the pump impellers.
  - 2) Pipe Cleaning function to start pump regularly to avoid sedimentation in pump impeller
  - 3) Cavitation Pump Protection
  - 4) Inlet protection to avoid system dry running.
- c. The VFD shall provide Application control functions
- 1) Stop and Go function to reduce consumption when VFD is in standby mode.
  - 2) Pulse input in order to connect a flow meter.
  - 3) Process control (PID) function to maintain a process at a given pressure or flow reference.
  - 4) Flow limitation function to allow limiting the consumption of water.
  - 5) Friction loss compensation function to compensate pressure losses in pipes due to friction.
  - 6) Pipe Fill function to manage a smooth control during pipe filling and to lessen the effects of water hammer.
  - 7) Sleep wake-up function to manage periods of the application when process demand is low and when it is not needed.
  - 8) Low demand function to define periods of the application when process demand is low to save energy.
  - 9) Jockey pump control function to start / jockey pump, during sleep period, to maintain emergency service pressure or demand such as low water.
  - 10) Sensor management to define how it will be used to drive inputs to manage pressure sensor or flow sensor
- d. The VFD shall provide Application protection functions
- 1) High flow protection function to detect pipe burst or detect running outside normal working area
  - 2) Outlet pressure protection function to fix minimum and maximum pressure.
- e. The VFD shall provide Pump curve input to help optimize pump performance.
- 1) Input and storage of the pump characteristics including 5 points of the pump curve.
  - 2) A best efficiency point (BEP) function to run in optimum conditions and detect deviation from this point.

F. Diagnostics and Configuration



1. The VFD Supplier shall have Windows based PC software for configuring and diagnosing the VFD. It shall be possible to set and modify parameters, control the drive, read actual values and make trend analysis using the software. The PC-tools may be connected to the VFD by wired or wireless connection.
  2. The VFD shall display all faults in plain text and help screens shall be available to guide the user in the troubleshooting. Codes are not acceptable.
  3. The VFD shall provide a Real Time Clock management for time stamping of detected errors.
  4. The VFD shall display detected errors with QR codes to guide the user in the troubleshooting.
  5. The VFDs must provide LED lights to indicate the status of the VFD.
  6. The VFD must have the ability to dynamically display I/O status.
- G. Energy Management
1. The VFD shall provide a data logging function to keep files ready for maintenance or user.
  2. The user interface shall be able to display a chart relative to energy efficiency and energy management.
    - a. Report in KW
    - b. Display energy history for instant, weekly, monthly, and yearly.
    - c. Trend base on variation /time
    - d. Power measurement accuracy shall be less than 5 %.
  3. The user interface shall be able to display the “efficient” set point for pump based on pump characteristics.
  4. The user interface shall be able to display the “efficiency board” including CO2 savings, Savings viewer, and Return of Investment.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of specifications Section 26 00 00 and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Pre-Installation Conference: Prior to commencing the installation, an onsite pre-installation conference shall review the material selections, installation procedures, and coordination with other trades. Attendees shall include, but shall not be limited to, the Contractor, the Installer, manufacturer’s representatives, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Engineer

- E. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- F. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

### 3.2 FACTORY ACCEPTANCE TESTING

- A. All VFDs shall be functionally tested at the factory by the manufacturer. A test report shall be submitted upon request by the Engineer.

### 3.3 FIELD QUALITY CONTROL

- A. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory-trained manufacturer's field service representative. This manufacturer's field service technician shall provide all material, equipment, labor and technical supervision to perform inspection, testing and adjustments to ensure equipment is installed, adjusted, and tested in accordance with the manufacturer's recommendations and is ready for operation. The manufacturer's field service technician shall replace damaged or malfunctioning equipment and report to the Engineer any discrepancies or issues with the installation.
- B. The manufacturer's representative shall, upon satisfactory completion of inspection and testing, attach a label to all serviced devices indicating the date serviced and testing company responsible.

### 3.4 FIELD TESTING AND COMMISSIONING

- A. Operational Readiness Testing
  - 1. The Contractor shall inspect and test furnished equipment and associated systems for conformance to the contract documents, including equipment manufacturer's recommendations, and readiness for operation. The test shall include the following as a minimum:
    - a. Visually inspect for physical damage and proper installation
    - b. Perform tests in accordance with manufacturer's instructions
    - c. Perform tests to ensure compliance with Contract Documents
    - d. Perform tests that equipment is ready for operation
    - e. Touch-up paint all chips and scratches with manufacturer-supplied paint and transfer remaining paint to Owner
  - 2. Contractor shall submit an operational readiness test report documenting all test results, including all assumptions, conditions, allowances and corrections made during the test. The report shall provide a listing of all modifications and adjustments made onsite to include any settings / parameters not identified as factory defaults within the equipment's O&M documentation. The test report shall include a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have

been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.

B. Functional Demonstration Testing

1. Prior to scheduling functional demonstration testing the Contractor shall submit a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.
2. The Contractor shall completely demonstrate the functionality and performance of the equipment and associated systems in the presence of Owner and Engineer, observing and documenting complete compliance with the Contract Documents.
3. The Contractor shall submit a written report documenting successful completion of functional demonstrating testing including all assumptions, conditions, allowances and corrections made during the test.

3.5 TRAINING

- A. O&M Training: Onsite training specific to the equipment furnished shall be provided to the Owner's staff by a factory trained manufacturer's representative. Training duration shall be sufficiently adequate to cover the operation and maintenance of the equipment and shall consist of not less than 2 repeated session(s) with 4 hours of onsite classroom and hands-on instruction for a minimum of 4 attendees per session.
1. The instructor shall provide sufficient time and detail in each session to cover the following as a minimum:
    - a. Theory of operation
    - b. Major components of equipment
    - c. Operation of equipment
    - d. Configurations of equipment
    - e. Maintenance, troubleshooting and repair
    - f. Replacement of component level parts
  2. The submitted O&M manuals shall be used for training. Manuals and documentation shall be provided to each participant for training.

**END OF SECTION**

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**SECTION 26 32 13.16**  
**NATURAL GAS-ENGINE-DRIVEN GENERATOR SETS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section provides requirements for furnishing, installation, and place in operation a natural gas-engine-driven generator set work as shown, scheduled, indicated, and as specified.
- B. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.
  - 3. Related Requirements:
    - a. It is the intent of this specification to secure an engine-driven generator set that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
    - b. Any exceptions to the published specifications shall be subject to the approval of the engineer and submitted minimum 10 days prior to the closing of the bid with a line-by-line summary description of all the items of compliance, any items that have been omitted or have been taken exception to, and a complete description of all deviations.
    - c. It is the intent of this specification to secure a generator set system that has been tested during design verification, in production, and at the final job site. The generator set will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the National Electrical Code and applicable local codes and regulations.
    - d. All equipment shall be new and of current production by an international, power system manufacturer of generators, transfer switches, and paralleling switchgear. The manufacturer shall be a supplier of a complete and coordinated system. There will be single-source responsibility for warranty, parts, and service through a factory-authorized representative with factory-trained technicians.

**1.2 REFERENCES**

- A. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- B. All material and equipment for which a UL standard exists shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- C. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical

society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the CONTRACTOR unless otherwise directed by the OWNER/ENGINEER.

- D. Equipment shall comply with applicable sections of the latest edition of the following standards:
  - 1. NEC.
  - 2. NFPA 37 and NFPA 110.
  - 3. IEEE.
  - 4. NEMA.
  - 5. ANSI.

### 1.3 ADMINISTRATIVE REQUIREMENTS – NOT USED

### 1.4 SUBMITTALS

- A. General Requirements: Comply with the submittal requirements of Section 01 30 00 "Submittal Procedures", and as described below.
- B. Shop Drawing submittals shall include, but not be limited to, the following:
  - 1. A written description of the system operation (written in this specification format) with all exceptions and/or deviations clearly highlighted or identified.
  - 2. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, and applicable equipment or devices clearly highlighted or identified.
  - 3. A written description of the maximum "starting" and "running" kVAs and kW's of the system equipment (charts and graphs will not be acceptable).
  - 4. A floor plan sketch complete with a dimensional description of the standby electric power system and associated equipment, locating the system equipment and accessories within the allotted space.
  - 5. Interconnection wiring diagrams to indicate terminal connections between the remote alarm annunciator panel and the electric set.
  - 6. Complete bill of material for all equipment.
  - 7. Complete warranty information as specified.
  - 8. A notarized letter from the system supplier certifying compliance with all requirements of this Specification.
  - 9. Performance test as specified in Paragraph 1.5/D of this Section.
- C. Manufacturer's Instructions for the shipping, handling, storage, installation, start-up, operation, and maintenance, with schedule, of the equipment (in both hardcopy and digital formats).
- D. Manufacturer's certification of satisfactory installation, calibration, and testing.
- E. Proof of Warranty as indicated.

### 1.5 QUALITY ASSURANCE:

- A. NEC and NFPA Compliance: Comply with applicable portions of the NEC (NFPA 70) including,

but not limited to, emergency and standby power generation systems and with NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", and NFPA 110, "Emergency and Standby Power Systems".

- B. IEEE Compliance: Comply with applicable Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards pertaining to generator construction.
- C. Performance Tests: The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include:
  - 1. Maximum power level.
  - 2. Maximum motor starting capacity.
  - 3. Structural soundness.
  - 4. Torsigraph analysis per MIL-STD-705B, Method 504.2.
  - 5. Fuel consumption.
  - 6. Engine-alternator cooling airflow.
  - 7. Transient response and steady state governing.
  - 8. Alternator temperature rise per NEMA MG1-22.40.
  - 9. Single step load pickup per NFPA 76A-822.
  - 10. Harmonic analysis and voltage waveform deviation per MIL-STD-705B, Method 601.4.
  - 11. Three-phase short circuit test for mechanical and electrical strength.
- D. Manufacturer: The system shall be built, tested, and shipped by the manufacturer of the Standby Electric Power System, who has been engaged in the production of engine-alternator sets and associated controls for a minimum of 10 years, so there is one source of supply and responsibility.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. The standby generator set(s) shall be stored at the factory until they must be shipped to the job site to prevent building construction delay.
- B. The standby generator set(s) shall be crated and covered to protect it from damage during shipment and subsequent storage at the job site.

#### 1.7 SITE CONDITIONS

- A. The equipment, sizes, materials, and arrangements described in this section are based on recommendations by equipment suppliers and shall be considered minimum limits of acceptability. The manufacturer shall be responsible for design, arrangement, and performance of all equipment supplied under this section.
- B. Environmental Conditions:
  - 1. All equipment including controls specified herein shall be specifically designed to be installed for this service and the environment encountered in this installation, unless noted otherwise.
  - 2. The environment will be moist, and corrosive, exhibiting hydrogen sulfide and other corrosive gases encountered in municipal wastewater treatment plants.

3. All equipment shall be designed and capable of operation outdoors at ambient temperatures of 10°F to 120°F, with indoor operating temperature of 140°F.

## 1.8 WARRANTY

- A. Extended Equipment Warranty: Refer to Section 01 78 36 "Warranties" for extended equipment warranty.
- B. All equipment furnished under this section shall have a special equipment warranty, in accordance with the Contract Documents, for a period of two (2) years after the date of Substantial Completion. The cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty and correction of defective work.

## 1.9 MAINTENANCE

- A. Extra material:
  1. Special tools: Provide to the Owner the special tools required for routine maintenance.
  2. Provide one spray can of matching finish paint for touching up damaged surfaces after installation.
- B. Maintenance Service:
  1. Provide a two-year Manufacturer's maintenance contract of the engine generator system. The two-year period shall begin from the date of Owner's acceptance. During this period, Manufacturer's maintenance staff shall visit the installation not less than 8 times for routine inspection and preventive maintenance. The maintenance visits shall be scheduled at 3-month intervals and shall be coordinated with the Owner and performed at times selected by the Owner. A written report of each maintenance visit shall be submitted to the Owner within 10 days. The Manufacturers shall submit a preventative maintenance schedule outlining in detail the following:
    - a. Time when services are to be performed.
    - b. Work to be performed.
    - c. Shutdowns required for service.
    - d. Company or Contractor support services required.
  2. The contract shall include, but not be limited to, the following:
    - a. Engine generator Manufacturer's recommended procedures for weekly inspection and maintenance to be done by user.
    - b. Quarterly inspections by the Supplier personnel to review the weekly maintenance record being kept by user and train any new Owner operating personnel.
    - c. Annual inspection shall include all of items in above paragraph and shall also include a 100% load test. The Supplier shall provide System load bank and load bank cables.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS



- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, are listed below:
1. Caterpillar Tractor Company.
  2. Cummins Power Generation/Onan Corporation.
  3. Generac Industrial Power.
  4. Kohler Company.
  5. MTU Onsite Energy.
  6. Steward & Stevenson.
  7. Taylor.

## 2.2 ENGINE-GENERATOR SETS:

- A. General: Provide a new natural gas outdoor rated engine-driven generator set, complete with safety devices, main output breaker, weatherproof enclosure, and vibration isolators. Unit shall be capable of continuous standby service.
- B. Design Basis: The standby generator set specified and shown on the Drawings is based on a natural gas generator and selected from data derived from manufacturer's engineering manuals and selection software.
- C. System Capacity: The engine-generator set, as a unit, shall be rated for a continuous standby capacity of 60 kW and 75 kVA at 0.8-PF, with an output of 90 amperes while generating 480Y/277 volt, 3-phase, 4-wire, 60 Hz power, and with performance as specified herein.
- D. Natural gas fired engine shall be a minimum 8 cylinder, naturally aspirated, fuel injected engine, water-cooled with belt driven water pump. Following items shall be included:
1. Valves: Intake and exhaust valves shall be heat-resisting alloy steel, free rotating. Exhaust valve seat inserts shall be replaceable.
  2. Battery Charging: 130-ampere automatic battery charging alternator with a solid-state voltage regulation and negative ground polarity
  3. Governor: Electronic isochronous governor capable of 1.0% steady-state frequency regulation
  4. Filters: Air cleaner, fuel and lube oil filters shall have replaceable elements + clear glass.
  5. Starting System: 12-volt positive-engagement solenoid shift-starting motor
  6. Fuel System: Operating fuel pressure for natural gas shall be between 7.0 and 11.0 inches of H<sub>2</sub>O.
  7. Lubrication System: Forced feed gear design lube oil pump; full pressure lubrication to all bearings; dual, full flow oil filters; oil level indicator; low oil pressure shutdown; lube oil cooler; and oil pressure gauge.
  8. Cooling System: The cooling system shall be unit mounted radiator cooled, self-sealing prelubricated coolant pump; belt driven pusher fan with wire guard; thermostat temperature control; high coolant temperature shutdown; low coolant level shutdown; intercooler. The cooling system shall be tested for leaks. As soon as the system has been tested, it shall be filled with ethylene glycol rust inhibiting and antifreeze solution sufficient to protect the system to 0°F. Engine-driven pusher type

cooling fan shall be sized to maintain safe operation at 122°F maximum ambient temperature. Airflow restriction from static pressure at the radiator discharge shall not be more than 0.5" of water.

9. Emissions Compliance: The generator set engine shall comply with all applicable Oklahoma Department of Environmental Quality (DEQ) Rules and Regulations and shall comply with all applicable EPA Tier Levels for Non-Road Engines that is currently in effect for the Oklahoma City area at the time of installation.
- E. Set Characteristics: Set manufacturer shall certify that reserve horsepower is available from the engine with all accessories operating in the ambient conditions hereinbelow. The engine-generator set shall be capable of picking up 100% of nameplate kW and power factor, less applicable derating factors, in one step with the engine-generator set at operating temperature, in accordance with NFPA 110, Paragraph 5.13.2.6, and including the following constraints:
1. Ambient conditions of 1000' altitude and an ambient temperature of 10 to 122°F.
  2. The rpm of the engine shall not exceed 1800 rpm and the engine piston speed shall not exceed 2000 per minute.
- F. Engine Protective Devices:
1. The engine protective devices shall provide automatic shutdown for overcrank, overspeed, high coolant temperature and low oil pressure. A low coolant level protective device shall be provided but shall alarm only and not initiate engine shutdown
  2. The high coolant temperature and low oil pressure shall have pre-shutdown signals.
  3. The overcrank alarm shall be the output of a solid-state cranking device preset at a 10 second cranking cycle and a 15 second rest cycle. If the engine fails to start on the third cranking cycle, the overcrank alarm shall sound and cranking shall stop. Unit shall be capable of repeating the above cranking cycle after the trouble has been cleared.
- G. Generator: Generator shall be 4-pole, revolving field type, brushless, dynamically balanced, skewed laminated, two thirds pitch wound, rotating rectifier exciter, temperature compensated solid-state voltage regulator, open dripproof, single bearing, permanently aligned generator connected to engine with flexible disc coupling, including the following:
1. NEMA Class H per UL1446.
  2. Temperature rise at rated load within NEMA MG1-32.40 definition.
  3. Double-sealed ball bearings, lubricated for life.
  4. Direct-drive centrifugal blower cooling.
  5. A 120-volt, single phase space heater shall be provided to prevent condensation in the generator.
  6. AC output leads shall be brought out to field connection busbars accessible through removable plates in the generator output junction box.
  7. The automatic voltage regulator shall be a solid-state design and include overvoltage and undervoltage protection functions. The voltage regulator shall be equipped with 3-phase RMS sensing. The regulator shall control buildup of ac generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the ac generator output voltage and in the event of regulator failure or loss of reference,

shutdown regulator output on a sustained overvoltage of one second duration. Over excitation protection shall sense regulator output and shutdown regulator output if overloads exceed 10 seconds Duration. Both overvoltage and over excitation protection shutdowns shall be latched, requiring generator set shutdown to reset.

- H. Generator Output Circuit Breaker(s): Generator set shall have 3 pole output circuit breaker(s) with solid state trip units as shown on the drawings. Breaker frame and trip ratings shall be as shown on the drawings. Breakers serving emergency and standby loads shall have breaker position indicating contacts. Breaker position indicating contacts shall be wired to initiate a generator control panel alarm when the breaker is open or tripped. Circuit breaker manufacturer and type for all breakers serving emergency and standby loads shall match the project electrical gear package to provide compatibility for selective coordination required by the NEC. Generator breakers shall have ground fault protection and shunt trip capabilities.
- I. Engine/Generator Set Performance:
  - 1. Frequency Regulation: Isochronous from no load to full rated load.
  - 2. Voltage Regulation: Plus 2% no load to rated load; rheostat for  $\pm 5\%$  voltage adjustment.
  - 3. Voltage Dip: Instantaneous voltage dip shall be less than 15% of rated voltage when full, 3-phase load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 5 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant with  $\pm 1\%$  of rated voltage. All unit performance characteristics shall be verified using an oscilloscope.
  - 4. Total Harmonic Distortion (THD): The sum of ac voltage waveform harmonics, from no load to full linear load shall not exceed 5% of the rated voltage (L-N, LL, L-L-L) and no single harmonic shall exceed 3% of rated voltage. Telephone Influence Factor (TIF) shall be less than 50 per NEMA MG1-22.43. Temperature rise at rated load and power factor shall be within NEMA MG1-22.40 definition.
- J. Engine-Generator Instrument Panel: The instrument panel shall be mounted on vibration isolators and shall have dc controls, ac controls, and panel lighting. The top of the instrument panel shall not be more than 6'-6" above finished floor.
  - 1. DC engine controls (2-wire, 24 volt system) including but are not limited to run-stop-automatic test-manual switch, remote start-stop terminals, oil pressure gauge, coolant temperature gauge, charge rate ammeter and running time hour meter.
  - 2. Solid state engine monitoring system with monitors in accordance with NEC Section 700, NFPA 110 and local code requirements with lamps, [audible alarm,] lamp test switch, individual alarm contacts and a common alarm contact for:
    - a. Overcrank shutdown
    - b. Low coolant temperature warning
    - c. Pre-warning for high engine temperature
    - d. High engine temperature shutdown
    - e. Pre-warning for low lube oil pressure
    - f. Low lube oil pressure shutdown
    - g. Overspeed shutdown

- h. Low fuel pressure
  - i. High fuel pressure
  - j. Low coolant level warning
  - k. Generator (EPS) supplying load.
  - l. Generator control switch not in auto position warning
  - m. High battery voltage warning
  - n. Low cranking voltage warning
  - o. Low battery voltage warning
  - p. Battery charger failure
  - q. Generator output breaker(s) open warning
3. Provide two dry auxiliary contacts one for common alarm and one for engine running to be monitored by the Plant Control System.
  4. AC output controls include, but are not limited to, an ac voltmeter; ac ammeter; voltmeter-ammeter phase selector with an "off" position; voltage adjusting rheostat; frequency meter; manual reset exciter circuit breaker and fine speed control potentiometer.
  5. Jacket-Water Heater: The engine shall have an 208 volt, 1-phase 2000W jacket-water heater supplied from a "normal" branch circuit. The jacket-water heater shall be complete with a thermostat capable of maintaining a water temperature of 25°C, with an ambient temperature of 0°C. A water temperature alarm, consisting of a contact closed when the jacket water temperature is below 20°C, shall be supplied.
  6. Exhaust System: Exhaust silencer(s) of the "critical" type, with side or end inlet as required. The exhaust silencer(s) shall be of chambered construction and shall provide maximum degree silencing and shall be sized to assure proper operation without excessive back pressure when installed in the exhaust system. The exhaust silencer(s) shall be supplied with condensation drains, flexible exhaust tubing, wall thimbles and rain caps, as required.
  7. Starting Batteries: Furnish and install fully charged 24-volt lead acid, impact resistant, storage batteries mounted on the unit or on a separate rack. Batteries shall have sufficient capacity for 60 seconds of continuous cranking per NFPA 99. Provide all required battery cables, connections, electrolyte and a battery hydrometer.
  8. Solid-State Battery Float Charger: A suitable 120 volt automatic SCR voltage regulated battery charger with a maximum charge rate, as recommended by the manufacturer, but not less than 10 amperes shall be provided to maintain each set of batteries at full capacity during standby conditions The maximum charging time to bring the batteries up to full charge shall not exceed 12 hours. The charger shall be provided with a remote alarm contact to indicate a charger failure condition. An ammeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger shall be so designed that it will not be damaged during the engine cranking and shall be interlocked such that it is not damaged during generator set operation. The charger may be furnished as a separate item with necessary cables and leads.
  9. Vibration Isolation: Suitable aluminum housed, spring type vibration isolators be provided. Isolators shall be sized to properly support the generator set and to isolate

99% of the generator's vibration from the supporting structure.

10. Skid Base: The entire packaged unit shall be mounted on a skid base of welded structural steel, of box type construction suitable for mounting on spring vibration isolators. A sloped drip pan shall be provided for containing engine fluid spills. Provisions for stub up of electrical and fuel connections shall be within the footprint of the generator set base rails.
11. Painting: The entire engine generator set shall have all exposed metal surfaces primed with a rust inhibiting primer and multiple finish coats of the manufacturer's standard machinery enamel finish.

### 2.3 ENCLOSURE:

- A. The complete engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated, rodent-proof enclosure.
  1. A Level 2, weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of not more than 78 dba @ 23 ft with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
  2. Level 2 Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF ENGINE-DRIVEN GENERATOR SETS:

- A. General: Install standby engine-driven generator sets where shown, in accordance with the equipment manufacturer's written instructions and recognized industry practices, to ensure that the sets comply with the specified requirements and serve the intended purposes.
- B. Standards: Comply with NEMA standards, requirements of the NEC and applicable portions of NECA's "Standard of Installation" pertaining to installation of standby engine-driven generator sets and accessories.
- C. Vibration Mounts: Install units on properly sized [inertia base with] spring type vibration mounts and ribbed neoprene vibration isolators; comply with manufacturer's indicated installation method as applicable.

### 3.2 GROUNDING:

- A. General: Install the generator(s) as a non-separately derived system. Do not ground the generator neutral to the generator frame. Ground the generator frame through the feeder grounding conductor. Refer to Section 26 05 26, "Grounding and Bonding for Electrical Systems", for additional requirements.

### 3.3 CONTROL WIRING:

- A. General: Provide generator start-up control wiring from automatic transfer switch to standby generator set.
- B. Annunciators: Provide control wiring to remote generator annunciators in locations

specified and as shown on the Drawings.

#### 3.4 INITIAL START-UP AND SYSTEM CHECKOUT:

- A. A complete installation shall be initially inspected, adjusted and started and checked out for operational compliance by representatives of the manufacturer. All start-up documentation shall be turned over to the OWNER.
- B. The engine lubrication oil and antifreeze shall be provided by the supplier of the electric set for operation under environmental conditions as recommended by the manufacturer.

#### 3.5 TESTING:

- A. General: Upon completion of installation of engine-driven generator set(s), transfer switches and after building circuitry has been energized with normal power source, test emergency power system to demonstrate standby capability and compliance with specified requirements, including automatic start-up, controls, and full load acceptance. Tests shall include operation of standby power system with voltage check while the system is loaded to ensure proper operation of the emergency generator, transfer switches, and other system components. Operation of the system shall simulate standby power conditions, that is, loss of main electrical power to the building. Test period shall be a minimum of 2-hours continuous trouble-free operation with at least four automatic transfer switch operations for each switch within the period of operation. All fuel for testing shall be provided under the project scope.
- B. Test Load: Testing shall be performed at 0.8 PF with loads as specified hereinbelow. Where the specific set has been factory tested at 0.8 PF as specified hereinbelow, field-testing may be performed at 1.0 PF. The supplier of the engine-generator set shall provide a load bank of sufficient capacity to complement the available building load for testing. The field test shall include running the emergency power system under loads as specified below:
  - 1. 30 minutes at 25% of rated load (field load bank).
  - 2. 1 hour at 50% of rated load (field load bank).
  - 3. 4 hours at 75% of rated load (field load bank).
  - 4. 4 hours at 100% of rated load (field load bank).
  - 5. Miscellaneous building loads may be used to supplement load bank.
- C. Test Readings: The voltage current and frequency readings shall be recorded at 15-minute intervals throughout the test. Each automatic transfer switch shall automatically operate a minimum of four times during the test. There shall be a 15-minute unloaded run at the conclusion of the test to allow engine to cool before shutdown. The Contractor shall make all necessary hook-ups to facilitate field-test and shall furnish all fuel necessary for field-testing.
- D. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include date and time of test, relative humidity, temperature, and weather conditions. Contractor shall provide minimum 15% of replacement parts plus 3 spare filters.

#### 3.6 OPERATOR TRAINING:

- A. The manufacturer's start-up representative shall provide a minimum of 2-hours of operating

and maintenance training to the Owner's maintenance personnel. Training shall be provided at times convenient to the Owner. Approved Operating and Maintenance Manuals shall be available to the Owner prior to the training session.

- B. Instructions and Drawings: Complete instructions, consisting of operating and maintenance manuals, parts book, dimensional drawings, separate unit wiring diagrams and schematics and interconnecting wiring diagrams shall be provided as part of the project operating and maintenance manuals.

### 3.7 IDENTIFICATION:

- A. General: Refer to Section 26 05 53, "Identification for Electrical Systems", for requirements concerning painting, nameplates, and labeling.

**END OF SECTION**

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**SECTION 26 36 13**  
**SERVICE ENTRANCE TRANSFER SWITCHES WITH BYPASS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Furnish and install automatic delayed transition transfer & bypass-isolation switch (ADUB) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each ADUB system(s) shall consist of a delayed transition transfer switch and a two-way bypass/isolation switch. All ADUBs and control modules shall be the product of the same manufacturer.
- B. The ADUB shall transfer the load in delayed transition (break-before-make) mode. Transfer is accomplished with a user-defined load disconnect period in both directions adjustable from 1 second to 5 minutes in at least 15 increments.
- C. Furnish an enclosure for the ADUBs that is suitable for service entry. It shall provide all of the proper disconnecting, protection, grounding and bonding required for service entrance equipment.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated. 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. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- C. Qualification Data: For manufacturer and testing agency.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  - 1. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than 8 hours from time of notification.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain automatic transfer switches bypass/isolation switches nonautomatic and transfer switches through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  1. UL 1008 - Standard for Transfer Switch Equipment
  2. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
  3. NFPA 70 - National Electrical Code
  4. NFPA 99 - Essential Electrical Systems for Health Care Facilities
  5. NFPA 110 - Emergency and Standby Power Systems
  6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
  7. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
  8. UL 508 Industrial Control Equipment
  9. UL 891 According to this UL standard the equipment shall be labeled: "Suitable for use only as service equipment."

#### 1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements of this Section, provide products by one of the following:
  1. ASCO, Inc., Series 7000
  2. Russelectric

#### 2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

#### 2.3 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operators shall be a solenoid mechanism, momentarily energized. The transfer switch unit shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time. Main operators which include overcurrent disconnect devices OR do not include electrical and mechanical interlocks will not be accepted.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact

pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

- D. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 800 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
- G. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

#### 2.4 BYPASS-ISOLATION SWITCH

- A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
- B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.
- C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.
- D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
- E. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
- F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

- G. Designs requiring operation of key interlocks for bypass isolation or ATS which cannot be completely withdrawn when isolated are not acceptable.

## 2.5 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to 1% of nominal voltage. Frequency sensing shall be accurate to 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
  - 1. EN 55011:1991 Emission standard - Group 1, Class A
  - 2. EN 50082-2:1995 Generic immunity standard, from which:
  - 3. EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
  - 4. ENV 50140:1993 Radiated Electro-Magnetic field immunity
  - 5. EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
  - 6. EN 61000-4-5:1995 Surge transient immunity
  - 7. EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
  - 8. IEEE472 (ANSI C37.90A) Ring Wave Test.

## 2.6 ENCLOSURE

- A. The ADUB shall be furnished in a Type 1 enclosure unless otherwise shown on the plans. ADUBs located outside shall be NEMA 4X, 316 SS with three point latching handle.
- B. The Service Entrance ADUB 400 amperes or less, shall be furnished in a single enclosure including a service (utility source) disconnect circuit breaker and an emergency source feeder disconnect circuit, as well as the power transfer switch, grounding and bonding provisions.
- C. The Service Entrance ADUB 600 amperes and above, shall be furnished in a multi-section switchboard as follows: a service equipment section containing the service (utility source) disconnect circuit breaker, grounding, and bonding provisions; plus, a second non-service section containing the power transfer switch and controls.

- D. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.
- E. A pressure disconnect link shall be provided to disconnect the normal source neutral connection from the emergency and load neutral connections for 4-mm wire applications. A ground bus shall be provided for connection of the grounding conductor to the grounding electrode. A pressure disconnect link for the neutral to ground bonding jumper shall be provided to connect the normal neutral connection to the ground bus.
- F. For those automatic transfer & bypass-isolation switches that are less than 1000 amperes, the connection between the normal disconnecting device and the ADTB shall be made with the appropriate size cable. For those automatic transfer & bypass-isolation switches that are greater than 1000 amperes, the connection between the normal disconnecting device and the ADTB shall be made with appropriate size bus. Bus shall be silver plated copper.

## 2.7 DISCONNECTING AND OVERCURRENT PROTECTION DEVICE

- A. For those Service entrance automatic delayed transition transfer & bypass-isolation switches less than 1000 amps, the normal connection shall be provided with a 2/3 pole, molded case circuit breaker with current ratings as shown on the plans.
- B. For those Service entrance automatic delayed transition transfer & bypass-isolation switches rated 1000 to 4000 amps, the normal connection shall be provided with 2/ 3 pole, stationary mounted circuit breaker with current ratings as shown on the plans. The circuit breaker shall be provided with instantaneous and ground fault trip settings. The circuit breaker shall trip open when the ground fault setting is exceeded.

## 2.8 OPERATIONS

- A. Controller Display and Keypad
  - 1. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:
    - a. Nominal line voltage and frequency
    - b. Single or three phase sensing
    - c. Operating parameter protection
    - d. Transfer operating mode configuration
    - e. (Open transition, Closed transition or Delayed transition)
  - 2. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.
- B. Voltage, Frequency and Phase Rotation Sensing
  - 1. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):
 

a. Parameter	Sources	Dropout / Trip Pickup / Reset
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b.	Undervoltage	N&E,3	70 to 98%	85 to 100%
c.	Overvoltage	N&E,3	102 to 115%	2% below trip
d.	Underfrequency	N&E	85 to 98%	90 to 100%
e.	Overfrequency	N&E	102 to 110%	2% below trip
f.	Voltage unbalance	N&E	5 to 20%	1% below dropout

2. Repetitive accuracy of all settings shall be within  $\pm 0.5\%$  over an operating temperature range of -20 C to 60 C.
3. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
4. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
5. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency and phase rotation.
6. The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye - Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.

C. Time Delays

1. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
2. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
3. An adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay all retransfer signals during initial loading of engine generator set.
4. Two time delay modes (which are independently adjustable) shall be provided on retransfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
5. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
6. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
  - a. Prior to transfer only.
  - b. Prior to and after transfer.

- c. Normal to emergency only.
  - d. Emergency to normal only.
  - e. Normal to emergency and emergency to normal.
  - f. All transfer conditions or only when both sources are available.
7. The controller shall also include the following built-in time delays for Delayed Transition & Bypass-Isolation operation:
    - a. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.
  8. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
  9. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port. The time delay value displayed on the LCD or remote device shall be the remaining time until the next event occurs.
- D. Additional Features
1. A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal. Switches which require utilizing the keypad and display function or have no manual time delay bypass means are not acceptable.
  2. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
  3. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the DUB is connected to the normal source and one contact closed, when the DUB is connected to the emergency source.
  4. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the DUB is connected to the normal source (green) and one to indicate when the DUB is connected to the emergency source (red).
  5. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
  6. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
  7. Terminals shall be provided for a remote contact which opens to signal the DUB to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
  8. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control

device.

- E. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
- F. Enable or disable the routine.
- G. Enable or disable transfer of the load during routine.
  - 1. Set the start time:
    - a. - time of day
    - b. - day of week
    - c. - week of month (1st, 2nd, 3rd, 4th, alternate or every)
  - 2. Set the duration of the run.
  - 3. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.
- H. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,
  - 1. Normal Failed
  - 2. Load on Normal
  - 3. TD Normal to Emerg
  - 4. 2min15s
- I. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.
- J. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- K. Data Logging - The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
  - 1. Event Logging
    - a. Date and time and reason for transfer normal to emergency.
    - b. Date and time and reason for transfer emergency to normal.
    - c. Date and time and reason for engine start.
    - d. Date and time engine stopped.
    - e. Date and time emergency source available.
    - f. Date and time emergency source not available.
  - 2. Statistical Data



- a. Total number of transfers.
  - b. Total number of transfers due to source failure.
  - c. Total number of days controller is energized.
  - d. Total number of hours both normal and emergency sources are available.
- L. Communications Module - Shall provide remote interface module to support monitoring of vendor's transfer switch, controller and optional power meter. Module shall provide status, analog parameters, event logs, equipment settings & configurations over embedded webpage and open protocol. Features shall include:
- 1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.
  - 2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
  - 3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be able to view the dynamic one-line; ATS controls status, alarms, metering, event logging as well as settings.
  - 4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.
  - 5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor's monitoring equipment.
  - 6. An event log displaying a minimum of ninety-nine (99) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.
  - 7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, five (5) serial ports, Termination dip-switches and LEDs for diagnostics.
  - 8. DIN rail mountable.
- M. External DC Power Supply - An optional provision shall be available to connect an external 24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead.
- N. Withstand and Closing Ratings
- 1. The ADUB shall be rated to close on and withstand the available RMS symmetrical short circuit current at the DUB terminals with the type of overcurrent protection shown on the plans.
  - 2. The ADUB shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 0.025 and 0.05 time based ratings. ADUB which are not tested and labeled with time based ratings and have series, or specific breaker ratings only, are not acceptable.
- O. Tests and Certification
- 1. The complete ADUB shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that

the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

2. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
3. The ADUB manufacturer shall be certified to ISO 9001:2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001:2008.

## 2.9 POWER METER

- A. Furnish Power Meters at locations shown to monitor all functions specified below.
- B. Power Meters shall be Shark Model 200.
- C. The Power Meters shall be listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20 C to 60 C.
- D. The Power Meter shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).
- E. The Power Meter shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 - 32VDC.
- F. Each Power Meter shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.
- G. The Power Meter shall accept inputs from industry standard instrument trans-formers (120 VAC secondary PT's and 5A secondary CTS.) Direct phase voltage connections, 800 VAC and under, shall be possible without the use of PTs.
- H. The Power Meter shall be applied in single, 3-phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.
- I. All setup parameters required by the Power Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.
- J. The following metered readings shall be communicated by the Power Meter, via Ethernet Ethernet/IP and TCP/IP serial communication, when equipped with optional serial communications module:
  1. Current, per phase RMS and neutral (if applicable)
  2. Current Unbalance %
  3. Voltage, phase-to-phase and phase-to-neutral
  4. Voltage Unbalance %
  5. Real power (KW), per phase and 3-phase total
  6. Apparent power (KVA), per phase and 3-phase total

7. Reactive power (KVAR), per phase and 3-phase total
  8. Power factor, 3-phase total & per phase
  9. Frequency
  10. Accumulated Energy, (MWH, MVAH, and MVARH)
- K. The following energy readings shall be communicated by the Power Meter:
1. Accumulated real energy KWH
  2. Accumulated reactive energy KVAH
  3. Accumulated apparent energy KVARH

#### 2.10 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.

#### 2.11 ELECTRICAL CONTROL DEVICES

- A. Pilot devices, relays, terminal blocks and other auxiliary equipment shown on control schematics, complying with Section 26 29 03 "Low-Voltage Pilot Control Devices."

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
1. Concrete Bases: Four 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.
- B. Identify components according to Division 26 Section 26 05 53 "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

#### 3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

#### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. 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.
- C. 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. Include external annunciation and control circuits. 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 3 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    - 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.
  7. Verify grounding connections and locations and ratings of sensors.
- D. Testing Agency's Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. 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.
- 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least 3 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - 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.
- E. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
  - 1. Verify grounding connections and locations and ratings of sensors.
- F. Coordinate tests with tests of generator and run them concurrently.
- G. 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.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. 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 Division 1 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

**END OF SECTION**

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**SECTION 26 41 00**  
**FACILITY LIGHTNING PROTECTION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The Section specifies the lightning protection system to be installed for the following buildings and structures:
  - 1. Wastewater Lift Station
  - 2. Lift Station Electrical Building
  - 3. Perimeter Fencing
- B. The work includes lightning protection for the structures, internal & external operational equipment, all contents, and occupants by preventing damage to the structure caused by lightning.

**1.2 REFERENCES**

- A. The following specifications and standards of the latest issue form a part of this specification:
  - 1. Underwriters Laboratories, Inc. Installation requirements UL 96A
  - 2. National Fire Protection Association, Installation NFPA 780 2014 edition

**1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures, and building materials; metal bodies requiring bonding to lightning protection components; and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

**1.4 SUBMITTALS**

- A. Product Data: For air terminals and mounting accessories.
- B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.
- D. Certification, signed by CONTRACTOR, that roof adhesive for air terminals is approved by manufacturer s of both the terminal assembly and the single-ply membrane roofing material.
- E. Field inspection reports indicating compliance with specified requirements.

**1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.
- B. The lightning protection system shall conform to the requirements and standards for lightning protection systems of UL and NFPA. Upon completion, application shall be made to the Underwriters Laboratories, Inc. for inspection and issuance of the UL Master Label and LPI-177 certification and inspection.
- C. The system to be furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment and shall be the manufacturer's latest approved design. The equipment shall be UL listed and properly UL labeled. All equipment shall be new and of a design and construction to suit the application where it is used in accordance with accepted industry standards as well as UL and NFPA requirements.

1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

1.7 SITE CONDITIONS - NOT USED

1.8 WARRANTY - NOT USED

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:
  - 1. Automatic Lightning Protection.
  - 2. ERICO International Corporation.
  - 3. Harger Lightning Protection, Inc.
  - 4. Heary Bros. Lightning Protection Co. Inc.
  - 5. Independent Protection Co.
  - 6. Robbins Lightning Inc.
  - 7. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Provide and install a complete lightning protection system in compliance with the specifications and standards of the most current editions of the National Fire Protection Association's Lightning Protection Standard NFPA 780, and Underwriters Laboratories Lightning Protection Standard UL 96 A. A lightning protection CONTRACTOR who is listed by Underwriters Laboratories, Inc. and a certified Master Installer by the Lightning Protection Institute shall install the system.
- B. Material Requirements:
  - 1. All lightning protection materials and components shall comply in weight, size and composition with class II UL 96 and NFPA 780 lightning protection material requirements. All materials shall be UL listed for lightning protection.
  - 2. Copper materials shall not be mounted on aluminum, Galvalume, galvanized steel or



zinc surfaces. This includes those materials that have been painted.

3. Aluminum materials shall not come into contact with earth or where rapid deterioration is possible. Aluminum materials shall not come into contact with copper surfaces or where exposed to runoff from copper surfaces. Aluminum materials shall not be attached to surfaces covered with alkaline-based paint, embedded in concrete or masonry, or installed in a location subject to excessive moisture.
4. Copper shall be used on all non-aluminum areas
  - a. Air terminals shall be a minimum of 1/2x12 inch solid copper
  - b. Cable shall be 28 strands of .066 inch diameter cable. 133,500 circular mils.
  - c. Connectors and splicers: Cast bronze mechanical with stainless steel bolt and nut.
  - d. Counterpoise shall utilize exothermic type connections to steel cable splicing and cable to ground rods.
  - e. Fasteners shall be copper with stainless steel anchors on masonry locations and stainless steel screws on wood and metal locations
5. Aluminum materials shall be used on all HVAC units, roof perimeters, and other roof surfaces that are aluminum. If the parapets utilize aluminum coping the roof system shall be completely aluminum except for down conductors & grounding equipment.
  - a. Air terminals shall be a minimum of 5/8x12 inch solid aluminum
  - b. Cable shall be 37 strands of .0756 diameter cable. 211,600 circular mils.
  - c. Connectors and splicers: Cast aluminum mechanical with stainless steel bolt and nut. Exothermic type for grounding connections and splicing below grade
  - d. Fasteners shall be aluminum with stainless steel anchors on masonry locations and stainless steel screws on wood and metal locations

C. Air Terminals

1. Air terminals shall extend a minimum of 10 inches above the object or area they are to protect. Air terminals shall be located at intervals not exceeding 20 feet along ridges of pitched roofs and along the perimeter of flat or gently sloping roofs (flat or gently sloping roofs include roofs that have a pitch less than 3:12). Flat or gently sloping roofs exceeding 50 feet in width shall be provided with additional air terminals located at intervals not exceeding 50 feet. Air terminals shall be located within 2 feet of the ends of ridges, roof edges and outside corners of protected areas.
2. Air terminals shall be installed on stacks, flues, mechanical units and other objects not located within a zone of protection. Permanent metal objects on the structure having an exposed metal thickness of 3/16 inches or greater may be substituted for air terminals and shall be connected to the lightning protection system as required by the specified standards using main size conductor and bonding plates having a minimum of 3 square inches of surface contact area.
3. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards. Fasteners may include stainless steel screws, bolts, nails, anchors or adhesive. Adhesive shall be compatible with the surface on which it is used. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing CONTRACTOR.
4. Main conductors shall be sized as Class I or Class II materials in accordance with the

specified standards. Conductors shall provide a 2 way, horizontal or downward path from each strike or air terminal to connections to the lightning protection ground electrode system. Conductors shall be free of excessive splices and no bend of a conductor shall form an included angle of less than 90 degrees nor have a radius of bend less than 8 inches.

5. Conductors shall be securely fastened to the structure on which they are placed at intervals not exceeding 3 feet. Fasteners shall be of the same material or of a material equally resistant to corrosion as that of the conductor. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing CONTRACTOR.
6. Connector fittings shall be listed for the purpose and of the same material as the conductor or of electrolytically compatible materials.
7. Down conductors shall be sized as Class II materials in accordance with the specified standards. Class II conductors from a higher portion of a structure shall continue to connections to the lightning protection ground electrode system. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than 2 down conductors. Where down conductors are installed exposed on the exterior of a structure and are subject to physical damage or displacement, guards shall be used to protect the conductor a minimum of 6 feet above grade. Metallic guards shall be bonded at each end.
8. In case of structural steel frame construction, down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals not exceeding 100 feet along the perimeter of the structure.

D. Roof Penetrations

1. Roof penetrations required for down conductors or for connection to structural steel framework shall be made using thru-roof assemblies with solid riser bars or conduits and appropriate roof flashing. Conductors shall not pass directly through the roof. The roofing CONTRACTOR shall furnish and install the materials required to properly seal all roof penetrations of the lightning protection components and any additional roofing materials or preparations required by the roofing MANUFACTURER for lightning conductor runs to assure compatibility with the warranty for the roof including roof pads that may be required to protect the roof under each of the lightning protection components.

E. Ground Electrodes:

1. Each down conductor shall terminate at a ground electrode dedicated to the lightning protection system, or to a building or facility ground electrode system that consists of multiple ground electrodes that are interconnected with a ground ring conductor.
2. Ground rod electrodes shall be copper-clad steel, a minimum 3/8 inch diameter and 10 feet long. The down conductor shall be connected to the ground electrode using a bronze ground rod clamp having a minimum of 1-1/2 inch contact between the ground rod electrode and the conductor measured parallel to the axis of the ground rod electrode, or by an exothermically welded connection. Ground rod electrodes shall be located a minimum of 2 feet below grade and shall be installed below the frost line where possible (excluding shallow topsoil conditions).
3. Where it is not possible to drive ground rod electrodes because of bedrock or shallow

topsoil conditions, ground plate electrodes, radial electrodes, ground ring electrodes, concrete-encased electrodes, or combinations of these may be used in accordance with NFPA 780.

4. Where the structural steel framework is utilized as down conductors for the system, ground electrodes shall be connected to columns around the perimeter of the structure at intervals averaging not more than 60 feet apart. Columns shall be grounded using either bonding plates having 8 square inches of surface contact area or by exothermically welded connections.

F. Common Bonding of Grounded Systems

1. Common bonding of all grounded systems within the building shall be ensured by interconnecting them to the lightning protection system using main size conductor and fittings.
2. For structures the interconnection of the lightning protection system ground electrodes and other grounded systems shall be in the form of a ground loop conductor.
3. These grounded systems shall include but are not limited to the electrical service, communication, and antenna system grounds as well as all underground metallic piping systems including water, gas, sewer, underground metallic conduits, etc. Interconnection to a gas line shall be made on the customer's side of the meter.

G. Potential Equalization

1. Grounded metal bodies located within the required bonding distance as determined by the bonding distance formula in NFPA 780 shall be bonded to the lightning protection system using the required bonding conductors and connections.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF CONDUCTORS

- A. General: Conductors shall be installed to interconnect all air terminals to the system of grounding electrodes, and in general provide a minimum of at least 2 paths to ground from any air terminal on the system. Conductors shall provide a horizontal or downward path between the system air terminals and grounding electrode system.
- B. Routing: Conductors shall be routed in such a manner that maximum concealment from public view is achieved. Down conductors may be installed in 1-inch PVC conduit from roof to grade.
- C. Counterpoise Conductors: Counterpoise conductors shall be installed after finished grades are established to insure specified depth and to minimize the possibility of damage. Any counterpoise conductor which is cut or damaged shall be repaired or replaced with no additional cost to the contract.
- D. Connections: All connections between conductors below grade shall be exothermically welded. Improper application of weld shall be replaced at no additional cost to the contract.

### 3.2 INSTALLATION OF GROUND RODS

- A. General: Ground rods shall be installed vertically at each down conductor position at a minimum of 2 feet from the building foundation wall. Inspection and documentation at each

grounded location, weld, depth of counterpoise, etc., shall be made prior to backfill. CONTRACTOR shall notify ENGINEER in writing to request inspection of underground work and for LPI inspection before backfill. Allow a minimum of 1 week for ENGINEER to make the inspection after notification from CONTRACTOR.

- B. Test Wells and Inspection Wells: Provide prefabricated test and inspection wells for all ground rods installed in paved or concrete areas.

### 3.3 BONDING OF SECONDARY METALLIC BODIES

- A. Structure Grounding: Provision shall be made at the roof level on reinforced concrete structures for bonding between the roof or down conductors, metallic elements of the roof system and metallic exterior wall systems.
- B. Bonding: All down conductors run in concrete columns shall be bonded to the reinforcing steel at the top and the bottom of the column.

### 3.4 GENERAL WORKMANSHIP

- A. General: All elements of the Lightning Protection System shall be installed in a professional and workmanlike manner consistent with the best industry practices.
- B. Concealed Installation: All system components shall be concealed to the maximum extent possible to preserve the aesthetic appearance of the project building on which the system is installed.

### 3.5 COORDINATION WITH OTHER TRADES

- A. Coordination: The CONTRACTOR shall coordinate his work with all trades, to ensure the use of proper materials and procedures in and around the roof in order not to jeopardize the roofing warranty.
- B. Fasteners: Where fasteners are to be embedded in masonry or the structural system, they shall be coordinated to insure installation at the proper time of construction.

### 3.6 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

### 3.7 INSPECTION, CERTIFICATION AND MAINTENANCE

- A. At completion of the installation of the lightning protection system, the CONTRACTOR shall apply for inspection of the system by UL field representatives. The system is to be inspected for compliance with NFPA 780.
- B. If the lightning protection system covers an entire independent structure and the system passes inspection, UL will issue a Master Label® Certificate of Inspection for Lightning Protection System. The CONTRACTOR will submit the certificate for distribution to the premises' OWNER. For the certificate to be valid, the CONTRACTOR must publish the certificate to the UL website, <https://lps.ul.com> where it may be viewed by consumers,

- building OWNERS, insurance agencies and other interested parties. The Master Label Certificate of Inspection is valid for a period of 5 years. If the building changes structurally or if modifications are made to the system during that period, the certificate is no longer valid.
- C. If the scope of the lightning protection system is limited by contractual or other reasons, the installer may limit the scope of the UL inspection. In those cases where the entire system is not inspected, a Master Label Certificate of Inspection will not be issued by UL. They will issue a Letter of Findings of their inspection indicating compliance with the limited scope of the inspection.
  - D. At project closeout, the CONTRACTOR shall provide the OWNER with accurate as-built drawings as well as recommended guidelines for maintenance of the system.

**END OF SECTION**

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**SECTION 31 05 00  
EARTHWORK MATERIALS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section provides the requirements for materials used for preparation of roadway fill, subgrade and base; structural subgrade and backfill; utility subgrade, bedding, embedment, and backfill; embankment and levee subgrade and fill; and other related work.

**1.3 SUBMITTALS**

- A. Submittals for Review.
  - 1. Samples: As required by Engineer, provide one-gallon sample in a sealed container.
  - 2. Contractor Design Mix Determination: Submit proposed design mix design for Controlled Low Strength Material and preliminary results demonstrating the mix design achieves required compressive strength.
- B. Submittals for Information.
  - 1. Source of Materials: Submit name and location of source of materials.
  - 2. Off-Site Borrow Source: Prior to furnishing off-site borrow (soils), provide notarized certification from the landowner stating to the best of landowner's knowledge and belief, the borrow source has never been contaminated by hazardous and/or toxic waste materials.
  - 3. Certified Analysis: Submit test results by independent qualified testing laboratory of material compliance with specifications. Results shall not be more than 30 days old.

**1.4 REFERENCES**

- A. Definitions.
  - 1. Well-Graded: A mixture of particle sizes that has no specific concentrations or lack thereof of one or more sizes producing a material type which, when compacted.
- B. Reference Standards: Following are standards that may be referenced in this Section.
  - 1. American Concrete Institute, ACI 229. – Controlled Low Strength Materials.
  - 2. ASTM International (ASTM):
    - a. C33 – Standard Specification for Concrete Aggregate.
    - b. C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
    - c. C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
    - d. C94 – Standard Specification for Ready-Mixed Concrete.
    - e. C117 – Standard Test Method for Material Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
    - f. C127 – Standard Test Method for Density, Relative Density (Specific Gravity),

- and Adsorption of Coarse Aggregates.
- g. C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - h. C136 – Standard Test Method for Sieve Analysis of Fine and coarse Aggregates.
  - i. C142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
  - j. C150 – Standard Specification for Portland Cement.
  - k. C535 – Standard Test Method for Resistant to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - l. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
  - m. D75 – Standard Practice for Sampling Aggregates.
  - n. D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
  - o. D1140 – Standard Test Method for Amount of Materials in Soils Finer than the No. 200 (75 micrometer) Sieve.
  - p. D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - q. D2940 – Standard Specification for Graded Aggregate Material for Bases or Subbases for highways or Airports.
  - r. D2974 – Standard Test Method for Moisture, Ash, and Organic Matter of Peat and other Organic Soils.
  - s. D4221 – Standard Test Method for Dispersive Characteristics of Clay Soil by Double hydrometer.
  - t. D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - u. D4832 – Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
  - v. D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter.
  - w. E11 – Standard Specification for Wire-Cloth and Sieves for Testing Purposes.
3. Oklahoma Department of Transportation, Standard Specifications (ODOT):
    - a. Sec. 303 – Aggregate Base
    - b. Sec. 703 – Bases and Miscellaneous Aggregates
    - c. L-18 – Fractured faces
    - d. L-38 – Soft particles
  4. American Association of State Highway and Transportation Officials (AASHTO):
    - a. T2 – Sampling
    - b. T11 – Material passing No. 200 sieve
    - c. T27 – Sieve analysis
    - d. T87 – Method of preparing samples
    - e. T88 – Particle Size Analysis of Soils
    - f. T89 – Determining liquid limit



- g. T90 – Determining plastic limit and plasticity index
- h. T96 – Los Angeles Abrasion, wear
- i. T180 – Maximum density (Method D)
- j. T210 – Aggregate durability index

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection.
  - 1. Stockpile excavated materials and imported materials in designated areas or in areas approved by ENGINEER. Clearly identify stockpiles.
  - 2. Lightly compact top and slop stockpiles to prevent excessive erosion and ponding of water.
  - 3. Store and handle materials in a manner to prevent contamination.
- B. Erosion and Sedimentation Control: Provide silt fences and surface drainage control at material stockpile areas in accordance with the Storm Water Permit.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Various site preparation, earthwork, trenching, and roadway subgrade and base Sections reference the materials listed in the following paragraphs. Not all materials listed are referenced in the Sections for this Project.
- B. Sampling of materials shall be in accordance with ASTM D75.

#### 2.2 GRANULAR MATERIAL

- A. Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel, or sandy loam. The material shall be free from lumps, stones over 2-inches in diameter, clay and organic matter. The imported material shall be classified as GW, GP, GM, GC, SW, or SP according to Unified Soil Classification System, ASTM D2487.

#### 2.3 COARSE AGREGATE

- A. Coarse aggregate shall consist of gravel, crushed gravel, and crushed stone. It shall consist of sound and durable particles, free from frozen materials or injurious amounts of salts, alkali, organic matter of other material either free or as adherent coating, and reasonably well graded between the prescribed limits listed below when tested in accordance with ASTM C136.
- B. Abrasion: It shall not wear more than 40 percent when tested in accordance with ASTM C131 or ASTM C535.
- C. Soundness: When material is subjected to five (5) cycles of the sodium sulfate soundness test in accordance with ASTM C88, the weighted percentage of loss shall not exceed 12 percent.
- D. Amount of material finer than 75-micrometer (No. 200) sieve: Coarse aggregate for embedment shall contain not more than one percent by weight organic matter (other than native bitumen), clays, loam or pebbles coated therewith, and shall contain not more than five percent by weight on any one or combination of slate, schist or soft particles of

sandstone.

- E. Each class of aggregate gradation shall comply with the applicable gradation limits listed in Table No. 1, when tested in accordance with ASTM C136.

**Table No. 1 – Coarse Aggregate Gradation**

Sieve Size	Aggregate Size No. 467 (1-1/2 to No. 4)	Aggregate Size No. 4 (1-1/2 to 3/4 in.)	Aggregate Size No. 57 (1 in. to No. 4)	Aggregate Size No. 67 (3/4 in. to No. 4)	Aggregate Size No. 8 (3/8 in. to No. 8)
	<b>Amounts Finer than Each Laboratory Sieve Mass Percent</b>				
2 in.	100	100	-----	-----	-----
1-1/2 in.	95 to 100	90 to 100	100	-----	-----
1 in.	----	20 to 55	95 to 100	100	-----
3/4 in.	35 to 70	0 to 5	-----	90 to 100	-----
1/2 in.	----	-----	25 to 60	-----	100
3/8 in.	10 to 30	0 to 5	-----	20 to 55	85 to 100
No. 4	0 to 5	-----	0 to 10	0 to 10	10 to 30
No. 8	----	-----	0 to 5	0 to 5	0 to 10
No. 16	----	-----	-----	-----	0 to 5

Aggregate Size Number and gradation is in accordance with ASTM C33 and ASTM D448.

**2.4 FINE AGGREGATE**

- A. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof, complying with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.
- B. The fine aggregate gradation shall comply with the applicable gradation limits, when tested in accordance with ASTM C136. Fine aggregate shall not have more than 45% passing any sieve and retained on the next consecutive sieve shown in Table No. 2 and, its fineness modulus shall not be less than 2.3 nor more than 3.1.
- C.

**Table No. 2 – Fine Aggregate Gradation**

Sieve	Percent Passing
3/8 in.	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	5 to 30
No. 100	0 to 10

Gradation in accordance with ASTM C33 Fine Aggregate

- D. Plasticity index shall be less than 6 for material passing No. 30 sieve.

**2.5 NATURAL GRAVEL**

- A. Natural gravel shall consist of uncrushed stones, washed and screened, complying with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.
- B. The fine aggregate gradation shall comply with the gradation limits listed in Table No. 3, when tested in accordance with ASTM C136.

**Table No. 3 – Natural Gravel Gradation**

<b>Passing or Retained on Sieve</b>	<b>Percent by Weight</b>
Passing 1-1/2 in.	100
Retained on 3/4 in.	100

2.6 CRUSHED STONE FOR FOUNDATION

- A. Crushed stone for foundations shall comply with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.
- B. The fine aggregate gradation shall comply with the gradation limits listed in Table No. 4, when tested in accordance with ASTM C136.

**Table No. 4 – Crushed Stone Gradation**

<b>Passing or Retained on Sieve</b>	<b>Percent by Weight</b>
Passing 5 in.	100
Retained on 2 in.	100

2.7 SAND

- A. Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles shall pass a No. 8 sieve and the material shall have a plasticity index of 12 or less.

2.8 PEA GRAVEL

- A. Pea Gravel: Conforming to ASTM C33, Aggregate Size No. 8, and coarse aggregate graded with 100 percent passing a 3/8-inch sieve and 90 percent retained on a No. 4 sieve.

2.9 CONCRETE ENCASEMENT

- A. Provide Ready mixed concrete prepared in accordance with ASTM C94. Select and proportion ingredients to obtain a minimum compressive strength of 3,000 psi at 28 days.
- B. Materials:
  - 1. Cement: ASTM C150, Type I or Type II.
  - 2. Aggregate: ASTM C33, Size 67 or similar.
  - 3. Fly Ash (if used): ASTM C618, Class C.
  - 4. Water: Clean, potable, free of odor, organics, and deleterious materials.
- C. Slump: Not less than one-inch, cushion portion of embedment; one to three inches for the sides and top of encasement.

2.10 CONTROLLED LOW STRENGTH MATERIAL (FLOWABLE FILL)

- A. Ready mixed flowable fill is a blend of cement, fly ash, fine aggregate, and water. It is designed as a low strength, flowable material requiring no subsequent vibration or tamping to achieve 100% consolidation.
- B. Unless indicated otherwise, select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832
- C. Materials:

1. Cement: ASTM C150, Type I, II, or III.
  2. Aggregate: ASTM C33, Size 8 or fine aggregate.
  3. Fly Ash (if used): ASTM C618, Class C.
  4. Water: Clean, potable, free of odor, organics, and deleterious materials.
- D. The flowable fill mixture shall be mixed either in a pug mill, concrete mixer, or transit mixer and shall a minimum slump of five (5) inches.

## 2.11 FLEXIBLE BASE

- A. Material Type: Unless otherwise specified, provide either crushed stone or crushed gravel shown on Table 5 and described below:
1. Crushed Stone: Ensure at least 40 percent of the completed Type A or Type B mixture retained on the No. 4 sieve contains uniformly graded, mechanically crushed particles with at least one fractured face.
  2. Crushed Gravel: Ensure 100 percent of the completed Type C or Type D mixture retained on the No. 4 sieve contains uniformly graded, mechanically crushed particles with at least two fractured faces. Ensure the completed Type C mixture contains no more than 15 percent natural sand.
- B. Material Grade: Unless other specified on the Drawings, aggregate used as flexible base material, shall comply with the requirements listed in Table 5, Grade B. Do not use additives such as, but not limited to lime, cement, or fly ash to modify aggregate to meet requirements of Table 5, unless shown on the Drawings.
- C.

**Table No. 5 - Aggregate Base Gradation**

Property		Type A	Type B	Type C	Type D
Master Gradation Sieve Size (% Passing)	3 inch	–	100	–	–
	2 inch	–	–	100	–
	1.5 inch	100	40-100	90-100	100
	1 inch	–	–	80-100	95-100
	3/4 inch	40-100	30-75	–	–
	1/2 inch	–	–	60-80	25-60
	3/8 inch	30-75	25-60	–	–
	No. 4	25-60	20-50	40-60	0-10
	No. 8	–	–	–	0-5
	No. 10	20-43	15-35	25-45	–
	No. 40	8-26	7-22	15-30	–
	No. 200 <sup>1</sup>	4-12	3-10	0-5	0-2
Liquid Limit % Max. <sup>2</sup>		25	25	25	–
Plasticity Index % Max. <sup>2</sup>		6	6	6	–

- 1.
2. Ensure the material passing the No. 200 sieve comprises no greater than two-thirds of the quantity of material passing the No. 40 sieve.
3. ODOT will allow blending of separate aggregates to produce an aggregate mixture if no individual aggregate has a plasticity index higher than 8.

4. For work under ODOT jurisdiction the base material shall comply with the requirements of ODOT Section 703, Type A, Type B, or Type C and the installation shall comply with the requirements of ODOT Section 303 unless otherwise indicated on the Drawings.

2.12 SELECT FILL

- A. Select fill shall be gravel, fine stone cuttings, sand, sandy loam, or loam free from excessive clay. Stone cuttings shall have no dimension greater than two-inches. Use approved material excavated from site or imported material.
- B. Select fill shall have a liquid limit of 35 or less; plasticity index between 5 and 18; and gradation approximately the limits indicated in Table No. 6. Maximum aggregate size: 1-3/4 inches.

**Table No. 6 – Select Fill**

Retained on Sieve	Percent by Weight
No. 4	25 to 50
No. 40	50 to 85
No. 200	30 to 50

2.13 IMPERVIOUS CLAY FILL

- A. Impervious clay fill shall be placed as indicated on the Drawings. The material shall not be used as backfill against walls of structures except in the upper two feet.
- B. The material shall consist of soil materials classified as CH or CL in accordance with ASTM D2487; have a minimum liquid limit of 40; have a minimum plasticity index of 20; have a minimum of 50 percent by weight passing a No. 200 sieve; and shall be free of organics or other deleterious materials.
- C. The material shall have a percent dispersion of less than 20 when tested in accordance with ASTM D4221. The material, when compacted to the recommended moisture and density, shall have permeability less than  $1 \times 10^{-6}$  cm/s (1 ft/yr), as determined by remolded specimens of the actual materials proposed, in accordance with ASTM D5084.

2.14 SITE FILL

- A. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3-inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- B. Material shall have a liquid limit of 40 or less; plasticity index between 4 and 20; and gradation approximately the limits indicated in Table No. 7.

**Table No. 7 – Site Fill**

Retained on Sieve	Percent by Weight
No. 4	Less than 35
No. 200	Less than 65

2.15 TOP SOIL

- A. Material shall be natural friable loam; free of subsoil, roots, grasses, and excessive amount of weeds, stone, and foreign matter.

- B. Material shall have an acidity range (pH) between 5.5 to 7.5; an organic matter content between 4 to 25 % in accordance with ASTM D2974; and a gradation complying with Table No. 8.

**Table No. 8 – Top Soil**

Retained on Sieve	Percent by Weight
No. 4	Less than 35
No. 200	Less than 65

**2.16 UNCLASSIFIED EXCAVATION**

- A. All material excavated from site not meeting the requirements for materials specified above.

**2.17 MATERIAL QUALITY CONTROL**

- A. Sampling of material stockpiles and material sources shall be in accordance with ASTM D75.
- B. Perform gradation analysis in accordance with ASTM C136 for:
  - 1. Coarse and fine aggregate, natural gravel, crushed stone for foundation, sand, select fill, impervious clay fill, earth fill, and topsoil.
- C. Perform abrasion testing in accordance with ASTM C131 or ASTM C535.
  - 1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
- D. Soundness testing in accordance with ASTM C88.
  - 1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
- E. Deleterious materials determination in accordance with ASTM C40, C117, and C142.
  - 1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
- F. Determine liquid limit and plasticity index in accordance with ASTM D4318.
  - 1. Sand for particles passing No. 8 sieve, select fill, impervious clay fill, and earth fill.
- G. Determine pH of topsoil in accordance with ASTM D2974.
- H. Determine permeability (hydraulic gradient) in accordance with ASTM D5084 and percent dispersion in accordance with ASTM D4221 of impervious clay fill materials.
- I. Provide tests results showing flowable fill mix design achieves desired compressive strength.

**2.18 CONTAMINATION TESTING AND CERTIFICATION**

- A. The CONTRACTOR shall arrange and pay for the services of an EPA approved laboratory to perform a toxic contaminant scan of composite borrow material samples furnished to the site which shall be representative of each separate borrow source in accordance with the U.S. Environmental Protection Agency protocol for the list of contaminants described in 40 CFR, Part 261, Appendix VIII and by EPA Methods SW-846. All costs for contamination testing and certification shall be considered subsidiary to construction, and no separate payment will be made.
- B. The CONTRACTOR, prior to proceeding to furnish soil borrow to the site, shall submit copies

- of the results of the laboratory scan to the ENGINEER. The test results shall indicate whether the presence of contaminants is above EPA acceptable levels. Any potential off-site borrow on which scan test results indicate the presence of contaminants above background levels will be rejected as an off-site soil borrow source.
- C. The laboratory performing the scan test for contaminants for the CONTRACTOR shall provide a written certification along with the test, which states that the laboratory is EPA approved and that the tests were performed according to EPA guidelines.
  - D. The CONTRACTOR shall obtain a written, notarized certification from the landowner, supplier or manufacturer of each proposed offsite borrow source stating that to the best of the landowner's, supplier's, or manufacturer's knowledge and belief, there has never been contamination of the borrow source site with hazardous or toxic materials. The CONTRACTOR prior to proceeding to furnish soil materials to the site shall submit these certifications to the ENGINEER. The lack of such certification on a potential offsite soil borrow sources will be cause for rejection of that source.
  - E. Soil materials derived from the excavation of underground petroleum storage tanks shall not be used as fill on this project.

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**

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**SECTION 31 05 19.13**  
**GEOTEXTILE**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnish labor, materials equipment, and incidentals necessary to install geotextile fabric. Use the geotextile in conjunction with aggregate for separation of aggregate from the subgrade in gabions applications and perimeter embedment wrap in trench applications, or other areas as shown in the plans. The geotextile should provide a permeable layer or media, planar flow, and tensile reinforcement, while retaining the soil matrix.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer shall maintain quality control procedures and shall provide periodic laboratory testing to provide quality control in accordance with ASTM testing procedures. The laboratory shall maintain records of its quality control results.

**1.3 SUBMITTALS**

- A. Submittals shall be prepared and submitted in accordance with SECTION 01 32 33 - PROJECT DOCUMENTATION.
- B. Submit test results demonstrating compliance with each requirement in Part 2.
- C. Furnish a manufacturer's certificate at the time of shipment with the following information for the fabric shipped for this project.
  - 1. Name of manufacturer.
  - 2. Chemical composition.
  - 3. Product description.
  - 4. Statement of compliance to specification requirements.
  - 5. Signature of legally authorized official attesting to the information required.
- D. Submit installation, handling and storage requirements.

**1.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Provide the geotextile in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris.
- B. Delivery, storage, and handling shall be in strict compliance with manufacturer's recommendations.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. The geotextile fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew, and rot resistant, insect and rodent resistant, and resistant to ultraviolet light exposure.
- B. The average roll minimum value (weakest principal direction) for the properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall exceed the average roll minimum value (weakest principal direction) stipulated in the

following table:

- C. The fabric shall be free of defects or flaws which significantly affect its physical properties. Each roll of fabric shall be labeled prior to shipment with the manufacturer, type and or model number of fabric and a number or symbol to identify that production run. Contractor shall furnish label to Owner for record purposes.

## 2.2 FABRIC TEST REQUIREMENTS:

Grab Strength ASTM D-4632 (Lbs.)	270
Grab Elongation ASTM D-4632 (%)	50
Mullen Burst Strength ASTM D-3786 (psi)	225
Permeability – k (cm/sec.) ASTM D-4491	0.14
Water Flow Rate (gal/min/ft <sup>2</sup> ) ASTM D-4491	100
AOS(O95) mm, ASTM-4751	0.21 (US Sieve No. 70)
Trapezoid Tear Strength ASTM D-4533 (Lbs.)	50
Puncture Resistance ASTM D-4833 (Lbs.)	100

- A. The average roll minimum value (weakest principal direction) for strength properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall be in excess of the average roll minimum value (weakest principal direction).
- B. Geotextile shall be non-woven fabric consisting only of continuous chain polymer filaments or yarns of polyester, formed into a stable network by needle punching.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install the geotextile in the trench to completely wrap all crushed stone embedment, separating crushed stone from foundation, sidewall, and trench overburden. Install the geotextile on the prepared subgrade and under the filter blanket as shown in the Plans. Overlaps shall be 36 inches in minimum. Fabric shall be secured as necessary by pins or other means before placing gabions or filters blanket material in place. The aggregate shall always be back dumped onto the fabric and spread in a uniform lift maintaining the design aggregate thickness. Construction vehicles shall not be allowed to traffic directly on the fabric.
- B. Avoid over-stressing the soil by utilizing equipment in spreading and dumping that exerts only moderate pressures on the soil. Severe rutting at the time of placement is an indication of over-stressing the soil. Such soil over-stressing must be avoided. Pressures may be reduced by increasing aggregate depths and reducing the loads.
- C. Fill any ruts which develop during spreading or compacting with additional aggregate. Do not blade subgrade from surrounding areas to fill ruts.
- D. Thoroughly compact the aggregate with a minimum of 8 passes of a 20-ton vibratory roller after placement.

**END OF SECTION**

**SECTION 31 10 00  
SITE CLEARING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section specifies site clearing activities including trees and vegetation removal and root grubbing, tree protection, topsoil stripping and stockpiling, capping and removing utilities, temporary erosion and sedimentation control measures, and removing minor above- and below-grade site improvements.
- B. This section does not include detailed tree protection and trimming, tree and root pruning, or tree relocation; grading, excavating, backfilling for earthwork and trenching; building and selective demolition; or landscaping.
- C. Related Sections include the following:
  - 1. Section 02 41 19 "Selective Demolition"
  - 2. Section 31 05 00 "Earthwork Materials"

**1.3 DEFINITIONS**

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter, including stumps, buried logs, and roots greater than two-inch caliber to a depth as specified in the following paragraphs.
- D. Scalping: Removal of sod without removing more than upper 3-inches of topsoil.
- E. Stripping: Removal of topsoil remaining after applicable scalping is completed.
- F. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
- G. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
- H. Project Limits: Areas, as shown or specified, within which work is to be performed.

**1.4 MATERIAL OWNERSHIP**

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

## 1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

## 1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: As applicable, carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 05 00 "Earthwork Materials".
  - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Storm Water Pollution Prevention Plan (SWPPP):
  - 1. CONTRACTOR shall obtain a permit to discharge storm water from the construction site from Oklahoma Department of Environmental Quality (DEQ) in accordance with NPDES General Permit No. OKR10 (Permit).
  - 2. The CONTRACTOR shall comply with all requirements of the Permit, including the development of a SWP3, filing of the Notice of Intent (NOI) and Notice of Termination

(NOT), record maintenance, and posting of the Permit.

3. Costs associated with obtaining and compliance with the Permit are the CONTRACTOR'S responsibility.
  4. Submit a copy of the SWP3 and other pertinent DEQ submittals to the ENGINEER and the OWNER two weeks prior to submitting to DEQ.
- B. Temporary Erosion and Sedimentation Control:
1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff to adjacent properties and walkways, according to a sediment and erosion control plan, specific to the site, which complies with the requirements of DEQ, or EPA 832/R-92-005, or requirements of authorities having jurisdiction, whichever is more stringent.
  2. The CONTRACTOR shall have the sole responsibility for the means, methods, techniques, sequences, and procedures for furnishing, installing and maintaining the erosion and sedimentation control system.
  3. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
  4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
  5. Close out the SPPP permit with ODEQ and provide that receipt to relevant local authorities.

### 3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: If applicable, do not interrupt utilities serving facilities occupied by OWNER or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify ENGINEER not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without ENGINEER'S written permission.
- C. Excavate for and remove underground utilities as indicated to be removed.

### 3.4 LIMITS OF CLEARING

- A. As follows, but not to extend beyond Project limits shown on the Drawings.
1. Excavation, Excluding Trenches: 5 feet beyond top of cut slopes.
  2. Trench Excavation: 4 feet from trench centerline, regardless of trench width.
  3. Fill:
    - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
    - b. Stripping: 2 feet beyond toe of permanent fill.
  4. Roadways: Clearing and grubbing 20 feet from roadway centerline.
  5. Overhead Utilities: Clearing and grubbing entire width of easements and rights-of-way.
  6. Other Areas: As shown on drawings.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

### 3.5 BLASTING

- A. Explosives: Do not use explosives.

### 3.6 BURNING

- A. Burning is not allowed on this Project.

### 3.7 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
  - 4. Use only hand methods for grubbing within tree protection zone.
  - 5. Chip removed tree branches and dispose of off-site.
- B. As required, fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### 3.8 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Limit height of topsoil stockpiles to approximately 6 feet.
  - 2. Do not stockpile topsoil within tree protection zones.
  - 3. Dispose of excess topsoil as specified for waste material disposal.

### 3.9 SITE DEMOLITION

- A. Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Neatly saw-cut length of existing pavement to remain at the line of demolition before removing existing pavement. Saw-cut faces vertically.
  - 2. Epoxy coat cut ends of steel reinforcement in concrete to remain to prevent corrosion.

### 3.10 DISPOSAL

A. Disposal:

1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
2. Dispose of stockpiled waste materials within 30-days.
3. When requested by OWNER, provide copies of the landfill receipts for waste material disposal.

**END OF SECTION**

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**SECTION 31 23 16**  
**EXCAVATION SUPPORT AND PROTECTION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes temporary excavation support and protection systems.

**1.2 RELATED SECTIONS:**

- A. SECTION 31 05 00 - EARTHWORK MATERIALS  
B. SECTION 31 23 19 - DEWATERING

**1.3 SUBMITTALS**

A. INFORMATIONAL SUBMITTALS

1. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, include analysis data signed and sealed by the qualified professional engineer, licensed to practice in the state where the Project is constructed, responsible for their preparation.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, licensed to practice in the state where the Project will be constructed, using performance requirements and design criteria indicated.
- B. As a minimum, the Excavation Support and Protection Plan shall address the following items:
1. Provide details of shoring, bracing, sheet piling, soldier piles and lagging, tie backs, and other support systems and provisions for worker protection from hazards of caving ground.
  2. Methods and sequencing of installing excavation support.
  3. Proposed locations for excavated materials.
  4. Minimum lateral distance from the crest of slopes for vehicles, equipment, and stockpiled materials.
  5. Prevent surface water from entering excavations by grading, dikes, or other means.
  6. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
  7. Monitor vibrations, settlements, and movements.

## 1.5 PROJECT CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Engineer will not be responsible for interpretations or conclusions drawn from the data.
- B. Additional Test Borings. Contractor shall make additional test borings and conduct other exploratory operations necessary for support and protection.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
  - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.
- F. TRENCHES
- G. For excavations exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and Federal requirements.

### 3.2 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
  - 1. Fill voids immediately with approved backfill compacted to density specified in SECTION 31 05 00 - EARTHWORK MATERIALS.
  - 2. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.
  
- B. If the support or stability of existing structures or site improvements is dependent, leave excavation support and protection systems permanently in place. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.

**END OF SECTION**

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**SECTION 31 23 19  
DEWATERING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes construction dewatering.
- B. Dewatering is considered subsidiary to the Bid Item for waterline installation. No separate or additional payment shall be made for the installation, maintenance, or removal of the dewatering system.
- C. Related Sections:
  - 1. Section 31 05 00 "Earthwork Materials" for excavating, backfilling, site grading, and for site utilities.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer in Oklahoma, using performance requirements and design criteria expected to be encountered in the field.
  - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
  - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - 5. Remove dewatering system when no longer required for construction.

**1.4 SUBMITTALS**

- A. Action Submittal. Provide shop drawings for dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
- B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria generally expected to be encountered in the field.
- C. Informational submittals
  - 1. Qualification Data: For qualified Installer, land surveyor and professional engineer as applicable.
  - 2. Field quality-control reports.

3. Other Informational Submittals:
  - a. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations, if applicable.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.
- B. Regulatory Requirements: Comply with governing notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

#### 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: As applicable, do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  1. Notify Engineer no fewer than two (2) days in advance of proposed interruption of utility.
  2. Do not proceed with interruption of utility without ENGINEER's written permission.
- B. Project-Site Information: A geotechnical report has not been prepared for this Project. Contractor is directed to the original boring logs depicted on sheets C-800 through C-804 in the Contract Documents. Dewatering system shall be designed to comply with the performance requirements and design criteria generally expected to be encountered in the field under the project conditions. Owner will not be responsible for interpretations or conclusions drawn from this data.
  1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
- C. Survey Work: If applicable, engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 - EXECUTION

##### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
  2. Protect subgrades and foundation soils from softening and damage by rain or water

accumulation.

- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Monitor dewatering systems continuously.
- E. Promptly repair damages to adjacent facilities caused by dewatering.
- F. Protect and maintain temporary erosion and sedimentation controls.

### 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, pipelines and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.
- 3.3 FIELD QUALITY CONTROL
- A. Observation Wells: When shown on Drawings, provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.
1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
  2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

**END OF SECTION**



**SECTION 31 23 33**  
**TRENCHING, BACKFILLING, AND COMPACTING**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Trenching for the pipeline as well as subsequent embedment, backfill and compaction operations, necessary to install the pipe and electrical underground conduit as specified.

**1.2 QUALITY ASSURANCE**

**A. Referenced Standards:**

1. ASTM D698: Moisture Density Relationship of Soils using a 5.5 lb. Hammer and a 12-inch drop.
2. ASTM C131: Resistance to Degradation of small sizes and coarse aggregates by abrasion and impact in the Los Angeles Machine.
3. ASTM D4253-00 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
4. ASTM D4254-00 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
5. ASTM D1557-00 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>)).
6. ASTM D2922-01 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

**B. Related Sections:**

1. Section 01 33 00 – Submittals
2. Structural General Notes on Sheet S-100

**1.3 PROTECTION**

- A. Protect trees, shrubs and lawn areas to receive planting, and other features remaining as part of final landscaping.
- B. Protect benchmarks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic. Install and maintain bridging, planking and cants to provide access to Work.
- C. Protect excavations by shoring, bracing, sheet piling, underpinning, or by other methods, as required to prevent cave-ins or loose dirt from falling into excavations.
- D. Underpin or otherwise support adjacent structures which may be damaged by excavation Work. This includes service lines and pipe chases.
- E. Notify ENGINEER of any unexpected subsurface conditions.
- F. Where damage could result from continuing Work, discontinue Work in area until ENGINEER notifies the CONTRACTOR of required modifications.
- G. Protect bottom of excavations and soil around and beneath foundations from frost and freezing.
- H. Grade around trenches to prevent surface water runoff into excavated areas.

- I. Protect above or below grade utilities including lateral lines, sprinkler system lines, and all other lines which are to remain. The cost of replacing damaged lines is to be borne by the CONTRACTOR.

1.4 SUBMITTALS

- A. Submit the following information in accordance with the requirements of Section 01 33 00.
  - 1. Shop Drawings:
    - a. Submit detailed sieve analysis data on embedment and backfill material to be placed in pipe zone.
  - 2. Certified Test Report
    - a. Submit soil resistivity for backfill material to be placed in pipe zone.
  - 3. Sample
    - a. Submit sample of materials to be used in pipe zone.

PART 2 - PRODUCTS

2.1 BED AND FILL MATERIALS

- A. A. Embedment: Crushed Stone for Concrete ASTM C-33, #67, CCFRPM and Ductile Iron Pipe Embedment:
  - 1. Crushed stone embedment shall consist of angular sound, durable stone material graded between the prescribed limits:

Sieve Size	Percent Retained
2"	0
1-1/2"	0
1"	0 to 10
3/8"	45 to 80
No. 4	95 to 100

- 2. Crushed stone embedment shall not contain more than 1 percent by weight of organic matter, loam, or clays, or more than 5 percent by weight of any one or combination of slate, shale, schist, or soft particles of sandstone.
- 3. The percent of wear shall not exceed 40 percent when tested in accordance with ASTM C131.

- B. Embedment: ODOT 703.01, Type A Aggregate Base

- 1. Granular bedding for concrete pipe, PVC pipe, flexible pipe, fiberglass manholes and fiberglass structures shall be ODOT 703.01, Type A Aggregate Base with the following gradation:

Sieve Size	Percent Retained
No. 8	0
No. 10	57 to 80
No. 40	74 to 92
No. 200	88 to 96

- C. Backfill:

1. Granular backfill shall be sand or hydraulically graded crushed stone fines, or mixed sand and gravel or sandy loam. The material shall be free from lumps, stone over 1-inch in size, clay, and organic matter.
  2. The plasticity index of the fraction passing the No. 40 sieve shall not exceed 10.
- D. Select Material:
1. Select Materials shall be gravel, fine rock cuttings, sand, sandy loam or loam free from excessive clay.
  2. Select Material shall have a liquid limit less than 40 and a plasticity index less than 20 for the fraction passing the No. 40 sieve.
  3. The percent passing the No. 200 sieve shall not be greater than 35 percent.
  4. Select material may be excavated on site or borrowed from an outside source.
- E. Site Backfill:
1. Material excavated on site excluding large rock or borrowed from an outside source.
- F. Topsoil:
1. Imported topsoil shall be friable loam free from subsoil, roots, grass, weeds, stones and foreign matter.
  2. Use topsoil stockpiled on site.
- G. Unclassified Material:
1. All material excavated on site, not meeting the requirements for topsoil, or fill material.
- H. Concrete:
1. Concrete shall conform to the Structural general Notes on Sheet S-100.
- I. In addition to all other requirements, material furnished for use as backfill material in the pipe zone for ductile iron, concrete steel cylinder and steel pipe shall have a resistivity of not less than 5,000 ohms-cm. Any material found to have a resistivity less than that required by this specification shall be removed from the project and disposed at the CONTRACTOR's expense. Pipe zone is defined as the zone from the bottom of the excavated trench to 1-foot above the top of the pipe.
- J. Crushed Stone for Trench Foundation
1. Where crushed stone or coarse gravel is required for drainage of water away from the trench foundation, restorage of trench foundation, or other purposes, it shall be angular crushed stone with the following grading requirements:

Sieve Size	Percent Retained
5"	0
2"	100

### PART 3 - EXECUTION

#### 3.1 PREPARATION AND LAYOUT; AND CLEARING AND GRUBBING

##### A. Preparation and Layout

1. Establish extent of excavation by line and elevation. Designate and identify datum elevations.

2. Set required lines and levels.
  3. Maintain benchmarks, monuments and other reference points.
- B. Clearing and Grubbing
1. The CONTRACTOR shall do all clearing and grubbing necessary for construction operations. All trees, branches, limbs, and roots shall be removed and disposed of by the CONTRACTOR so as to leave the OWNER right-of-way in a neat and presentable condition. Clearing and grubbing shall be accomplished so as not to injure or damage adjacent property. The blade of the machine used for clearing and grubbing outside the permanent easement, but within the temporary construction easement shall be kept slightly above the ground surface to protect grass roots. Within the limits of the permanent easements, all stumps, roots, etc., shall be removed to a depth of at least two (2) feet below the existing ground surface. Any and all damages outside the limits of the construction right-of-way shall be paid and settled by the CONTRACTOR at his expense.
  2. The CONTRACTOR shall abide by all conditions set forth in the Contract Documents and site certificate documents.
  3. All materials cleared and grubbed shall be disposed of properly. At the time of final acceptance of the project, the work shall be neat and satisfactory in appearance, free from all weeds, brush, rubbish, stumps, and bushes.
  4. No separate measurement and payment will be made for clearing and grubbing but will be considered subsidiary to work required for the project.

### 3.2 UTILITIES

- A. Known underground utilities are indicated on the Drawings.
- B. Before starting excavation, establish the location and extent of underground utilities occurring in the work area.
- C. As excavation approaches utilities, hand excavate to uncover utilities.
- D. Notify the ENGINEER for direction for removal and/or relocation of utility companies' lines which are in the way of excavation.
- E. Maintain, re-route or extend as required existing utility lines to remain which pass through the work area with the approval of the OWNER. Relocations are at the CONTRACTORS cost.
- F. Protect active utility services uncovered by excavation.
- G. Accurately locate and record abandoned and active lines rerouted or extended on Project Record Documents.

### 3.3 TRENCHING

- A. Ensure trenching does not interfere with normal 45 degree bearing splay of any foundation.
- B. Excavate in accordance with lines and grades. Excavated material shall be placed adjacent to the work to be used for backfilling if the material meets specifications for embedment and/or backfill.
- C. Trench depths and grading are calculated to provide adequate cover over pipes. Notify ENGINEER if adequate cover is lacking and correct as directed by ENGINEER.
- D. Cut trenches sufficiently wide to enable proper installation of services and to allow for

- inspection. Trim and shape trench bottoms and leave free of irregularities, lumps and projections. Over excavated trench depths shall be filled to the proper grade with crushed rock at no additional cost to the OWNER.
- E. Trench width in the pipe zone (pipe zone designated as the zone from the trench bottom to at least one (1) foot above the top of the pipe) shall be vertical. The walls of the excavation above this specifically designated pipe zone may be laid back where room permits, as necessary, and shall be constructed as required by the safety laws of OSHA, federal, state, municipal and any other agency having jurisdiction over the Work.
  - F. The maximum width of the trench excavation in the pipe zone shall be no more than 36 inches wider than the outside diameter of the pipe barrel. Whenever the prescribed maximum trench width is exceeded, the CONTRACTOR shall use the next higher class of embedment and the next higher class of pipe, at no additional cost to the OWNER.
  - G. The minimum width of the trench excavation throughout the pipe zone shall be the outside diameter of the pipe barrel plus 12 inches (6 inches on either side of the pipe).
  - H. Do not disturb soil within branch spread of existing trees or shrubs that are to remain. If it is necessary to excavate through roots, perform work by hand and cut roots with a sharp axe.
  - I. When complete, request the ENGINEER to inspect excavations. Correct unauthorized excavation as directed, at no cost to the OWNER.
  - J. The trench shall be excavated to an even grade to permit the installation of the pipe in such a manner that the full length of the pipe barrel is supported on the proper depth of granular embedment material. The entire foundation area in the bottom of all excavations shall be firm, stable material, and material shall not be disturbed below required grade except as described in this article. Where the character of the foundation materials is such that a proper foundation cannot be obtained at the elevation indicated on the Plans, then, when directed by the OWNER in writing, the CONTRACTOR shall deepen the excavation to where a satisfactory foundation can be obtained.
  - K. If the subgrade is soft, spongy, or disintegrated, the materials shall be removed until a firm, stable and uniform bearing is reached and the subgrade brought back to the required grade with crushed stone embedment material compacted in place or with concrete. If the unsatisfactory subgrade condition is due to the CONTRACTOR's failure to make a proper provision for adequate drainage or dewatering of excavations, the expense of replacing any unsatisfactory subgrade shall be borne by the CONTRACTOR. However, if, in the opinion of the OWNER, the unsatisfactory subgrade condition is not the result of the failure of the CONTRACTOR to provide adequate drainage, bailing or pumping facilities and the OWNER orders in writing that the CONTRACTOR make additional excavation and replace unsatisfactory subgrade material with crushed stone embedment material or Class B concrete, then compensation will be made for the additional expense incurred at the unit price provided in the Proposal.
  - L. Unsuitable excavated subsoil including perishable, spongy material, large rock, or other material designated by the OWNER shall not be used in backfilling. Unsuitable material shall be disposed of by the CONTRACTOR in a manner approved by the OWNER.

### 3.4 SHEETING AND SHORING

- A. In caving ground or in wet, saturated or flowing or otherwise unstable materials, the sides of all trenches and excavations shall be adequately sheeted and braced, to maintain the

excavation from slides or cave-ins and to provide safety for workmen.

- B. Sheeting, shoring, and bracing shall stay in place of the pipe zone requires shoring, otherwise it shall be removed. Removal of sheeting, shoring, and bracing shall be performed in a manner to prevent damage to new or existing structures and to avoid cave-ins or sliding of the banks. All holes and voids from the sheeting shall be immediately and completely filled and compacted with suitable materials. All costs associated with the abandonment of sheeting, shoring and bracing shall be borne by the CONTRACTOR.

### 3.5 DEWATERING

- A. Keep trenches dry. Provide necessary equipment including pumps, piping and temporary drains. Groundwater levels shall be maintained at least two (2) feet below the base of the excavation for the duration of construction.
- B. Direct surface drainage away from excavated areas. Provisions shall be made for the satisfactory disposal of water pumped to prevent damage to public or private property.
- C. Control the grading in and adjacent to excavations to prevent water running into excavated areas or onto adjacent properties or thoroughfares.
- D. Furnish and operate suitable pumps on a 24-hour basis to keep excavations free of water until services have been placed and backfilling is completed.

### 3.6 BEDDING

- A. Manually place and compact bedding material in loose lift layers not exceeding 8 inches.
- B. Manually shape bedding material to conform to pipe barrel and bell or flanges such that the entire length of the pipe barrel is supported by the bedding material.
- C. Granular backfill and embedment materials shall be placed as shown on the drawings and compacted in 8-inch loose lift layers to a minimum depth of 12 inches over the top of the pipe.

### 3.7 BACKFILLING

- A. Do not start backfilling until services have been inspected.
- B. Ensure trenches are free of building debris, snow, ice, and water and that ground surfaces are not in a frozen condition.
- C. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.
- D. Place and compact backfill materials in continuous layers according to the method of compaction used. Use a method which will not disturb or damage services. No excessively large rocks (1-inch or larger) or debris of any sort shall be used as backfill.
- E. Maintain optimum moisture content (optimum to 2 percent wet of optimum) of fill materials so as to attain required compaction density.
- F. Acceptable backfill from the excavation shall be placed from twelve inches over the pipe to the surface.
- G. Pipe supported on piers that is installed below grade shall have a minimum 12 inches of backfill around pipe consisting of select material as specified herein with no rocks, stones, clods, etc., larger than 1-inch in size.

- H. Excavated unsuitable material and excess material shall be disposed of by the contractor off site and at an approved location.

### 3.8 COMPACTION

- A. Compact embedment materials with hand-operated mechanical compaction devices.
- B. All embedment material, which includes material placed in trench bottom for pipe foundation, and all backfill material within the pipe zone shall be compacted to a minimum of 95 percent of maximum dry density defined by ASTM D698 or to a minimum of 75 percent relative density determined by ASTM D4253 and D4254, whichever is applicable.
- C. Outside Paved Areas: Backfill materials shall be thoroughly compacted by mechanical or pneumatic tamping in layers not to exceed 9 inches in compacted thickness. Care must be taken to avoid pipe damage. Compact backfill material to 85 percent (minimum) standard Proctor (ASTM D698).
- D. Within Paved Areas: Backfill under roads shall be mechanically or pneumatically compacted to 95 percent of maximum dry density as defined as ASTM D698 in layers not exceeding 6 inches of compacted thickness.
- E. Remove and replace improperly compacted backfill material at no cost to OWNER.
- F. Water jetting for consolidation will not be permitted.
- G. Compact backfill and embedment materials at moisture contents of optimum to 2 percent wet of optimum for cohesive materials and as necessary to achieve specified density for noncohesive materials. CONTRACTOR shall provide compaction tests at a minimum of every 150 feet of trench length per lift (as directed by the OWNER) and as deemed necessary by the CONTRACTOR to ensure adequate compaction is being achieved. CONTRACTOR'S compaction tests shall be performed at CONTRACTOR'S sole expense and will be considered subsidiary to construction.
- H. Additional Compaction tests at intervals of 500 feet of trench length and vertical intervals of 10 feet of backfill depth may be directed by the OWNER at the OWNER'S expense. If OWNER provided tests determine that the embedment or backfill does not meet the required density the CONTRACTOR shall recompact the embedment until densities are met, or shall remove all embedment and add new embedment to meet the densities. The CONTRACTOR shall pay the cost of all additional retesting required by the OWNER.
- I. Field Density Testing
  - 1. Embedment Test Section: The CONTRACTOR shall coordinate with the OWNER trial test sections. The trial test section shall consist of at least two sections (joints, lengths) of pipe. The pipe shall be installed and the CONTRACTOR shall use his proposed method of placing and compacting the embedment. At least one length of pipe shall be carefully removed to allow the integrity of the embedment along the haunches and below the pipe to be evaluated visually and by in-place density testing to verify that the CONTRACTOR's method will achieve the specified density and uniformity of the embedment. Additional test sections shall be performed for all different embedment materials, if the CONTRACTOR proposes to change methods of placement and compaction. The means, methods, and techniques of placement and compaction shall be the sole responsibility of the CONTRACTOR, and the test sections shall be considered only as a means to verify that the CONTRACTOR's methods are capable of achieving the specified density. The actual quality of the embedment and

backfill, as compacted, shall be the responsibility of the CONTRACTOR and satisfactory results from the test section(s) and field density tests shall not be considered as a guarantee of the quality of the CONTRACTOR's embedment and backfill operations.

3.9 CLEAN UP

- A. Remove surplus fill and spoil materials.

**END OF SECTION**



**SECTION 31 70 00**  
**PIPE JACKING, BORING, OR TUNNELING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section provides for pipe installation by jacking, boring, directional boring or drilling, or by tunneling.
- B. Related Sections:
1. Division 31 Section 31 05 00 "Earthwork Materials."
  2. Division 31 Section 31 10 00 "Site Clearing" for site preparation, temporary erosion control measures, tee protection and other related work.
  3. Division 31 Section 31 23 19 "Dewatering" for dewatering requirements.
  4. Division 31 Section 31 23 16 "Excavation Support and Protection"
  5. Division 33 Section 33 05 31.23 "Piping system, Fusible PVC Pipe"

**1.3 REFERENCES AND DEFINITIONS**

A. References:

1. ASTM International (ASTM):
  - a. A 36 Specification for Carbon Structural Steel
  - b. A 139 Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
  - c. A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  - d. A 449 Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
  - e. A 760 Specification for Corrugate Steel Pipe, Metallic-Coated for Sewers and Drains
  - f. C 76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - g. C 150 Specification for Portland Cement
  - h. C 869 Specification for Foaming Agents Used in Making Performed Foam for Cellular Concrete
2. American Water Works Association (AWWA):
  - a. C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. for Water Distribution

B. Definitions:

1. Auger Boring: A technique for forming a bore from a drive pit to a reception pit, by means of a rotating cutting head. Spoil is removed back to the drive pit by helically wound auger flights rotating in a steel casing pipe.
2. Bentonite: Colloidal clay sold under various trade names that form slick slurry or gel when water is added. Also known as driller mud.
3. Carrier Pipe: The tube that carries the product being transported and which may go

through casings at highways and railroad crossing. It may be made of steel, concrete, clay, plastic, ductile iron, or other materials.

4. Casing: A pipe used to line bore holes through which a pipe(s) called carrier pipes or ducts are installed.
5. Directional Drilling: A steerable system for the installation of pipes, conduits and cables in a shallow arc using a surface launched drilling rig.
6. Dry Bore: Any drilling or rod pushing system not employing drilling fluid in the process.
7. Pipe Jacking: A system of directly installing pipes behind a shield machine by hydraulic jacking from a drive shaft such that the pipes form a continuous string in the ground.
8. Trenchless Technology: Techniques for utility line installation, replacement, rehabilitation, renovation, repair, inspection, location, and leak detection, with minimum excavation from the ground surface.
9. Tunneling: A construction method of excavating an opening beneath the ground without continuous disturbance of the ground surface and of large enough diameter to allow individuals access and erection of a ground support system at the location of material excavation.

#### 1.4 PERFORMANCE REQUIREMENTS

##### A. General Performance:

1. Carrier Pipe: Lateral or vertical variation in pipe's final position from the established Drawing line and grade shall not exceed 1-inch per 100-feet, provided such variation shall be regular, only in one direction, and the final grade of the flow line shall be in the direction indicated on the Drawings.
2. Structural Performance: Specified casing pipe thickness based upon the superimposed loads and not upon loads, which may be placed on the pipe resulting from jacking operations. Provide increase strength required to withstand jacking loads.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and manufacture instructions for casing pipe, carrier pipe, spacers, liner plates, and associated components as applicable.
- B. Shop Drawings: For bulkheads, access manholes, overall assembly, and related work as applicable. Include plans, elevations, sections, details, and attachments to other work.
- C. Design Mixes: Concrete, grout, and flowable fill as applicable.
- D. Qualification Data: For qualified Installer.
- E. Welding certificates.
- F. Material Certificates: For each type of material or product from the manufacturer.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel.

## 1.7 PROJECT CONDITIONS

- A. Construction Method: Unless otherwise specifically designated, CONTRACTOR may select jacking, boring, tunneling, or trenchless construction method to be employed.
- B. Permit:
  - 1. For those areas where CONTRACTOR proposes to use trenchless excavation operations in lieu of open cut, it shall be the responsibility of the CONTRACTOR to prepare documentation, obtain approval and required permits.
- C. Operation Restrictions: Conduct operations so as not to interfere with, interrupt, or endanger surface and activity thereon.
  - 1. Minimize subsidence of surface, structures, and utilities above and in vicinity of operations.
  - 2. Support ground continuously to prevent loss of ground and keep perimeters stable.
  - 3. Be responsible for settlement resulting from operations.
  - 4. Repair and restore damaged property to its condition before being disturbed at no cost to the OWNER.
  - 5. Provide 48-hour notice prior to commencement of any jacking, boring, tunneling, or trenchless operations.
- D. Compliance: Comply with applicable ordinances, codes, statutes, rules, and regulations of the jurisdictional agency, the affected Railroad, ODOT, and municipal, state and federal governmental agencies.
- E. Additional Criteria for Work Railroad Property:
  - 1. Do not schedule work until submittals and insurance approval received from Railroad and ENGINEER and permit, if applicable, has been obtained.
  - 2. Provide any additional insurance required by the Railroad or other jurisdiction agency.
  - 3. Comply with AREMA and other Railroad requirements prior to commencing Work.
  - 4. Obtain required Railroad safety training for operators performing Work within Railroad right-of-way, the required flagman, and work authorization from the Railroad. All costs associated with these activities shall be the CONTRACTOR'S responsibility.
  - 5. Place safety, precautionary, and protective devices and services required before Work proceeds.
- F. Safety Requirements:
  - 1. Provide flagman, barricades, lights, warning signs, ventilation, air quality monitoring, and other safety devices and equipment required to ensure the safety of personnel entering area, especially tunneling operations, safeguard traffic and pedestrians.
  - 2. Establish procedure to logging personnel working within the bore or tunnel shaft, if applicable.
  - 3. Compliance with requirements of Division 31 Section 31 23 16 "Excavation Support and Protection".
  - 4. Compliance with OSHA 29CFR 1926, and applicable criteria of ANSI A10.16-1995 (R2001) "Safety Requirements for Tunnels, Shafts, and Caissons".

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. General:

1. Material of construction of casing pipe shall be as designated on the Drawings or as required by the jurisdictional agency for type of service.
2. Material of construction for the carrier pipe shall be as designated on the Drawings.
3. Carrier pipe shall be placed inside a casing pipe where foundation conditions (presence of boulders, rubble, or rock) make the direct trenchless installation of the carrier pipe impractical. A casing pipe may also be used if the carrier pipe or conduit is not by itself suitable for trenchless installation.

#### B. Casing Pipe:

1. C900 Fusible PVC Pipe:
  - a. Smooth walled fusible PVC Pipe in accordance with C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. for Water Distribution
  - b. Casing size shall be as shown in the Casing Size Table in the plans.
  - c. Casing Pipe Class shall be DR 18 unless otherwise noted.
  - d. Joints shall be fusion butt-welded in the field in accordance with Division 33 Section 33 05 31.23 "Piping system, Fusible PVC Pipe".
  - e. Coating: None.

#### C. Carrier Pipe:

1. Material of construction shall be as shown on the drawings and shall have restrained joints.
2. Carrier pipe shall be the same nominal diameter as the system pipe on either side of the carrier pipe.

#### D. Casing Spacers:

1. Factory manufactured casing spacers shall be installed on all carrier pipes passing through a casing pipe. Wooden skids will not be allowed as an alternative.
2. Bolt-on style with a shell made of at least two halves, having band material manufactured of minimum 14 gauge hot rolled pickled steel or T-304 stainless steel, and 10 gauge risers.
3. Steel Band and risers shall have a copolymer-based thermoplastic coating finish, 10-15 mil thickness.
4. Spacer 8-inch wide carrier pipe size 24-inch and smaller, 12-inch wide 26-inch and larger.
5. Hardware; T-304 for stainless bands, or electro-plated for steel bands.
6. Liner, EDPM, 0.090-inch thicken, hardness Durometer "A" 85-90, Dielectric strength 60,000 VPM, and water adsorption of 1% maximum.
7. Runners, 1-inch or 2-inch wide, glass filled polymer plastic.
8. Available Manufacturers:
  - a. Advance Products & Systems, Inc.
  - b. Cascade Waterworks Mfg.

- c. GPT, Inc.
- E. Casing End Seals:
  - 1. Manufactured of 1/8-inch thick neoprene rubber, attached using 1/2-inch wide T304 stainless steel bandings 100% non-magnetic worm gear mechanism.
  - 2. Configuration may be pull-on end molded, wrap around with self-curing mastic sealing strips, or zipper configuration.
  - 3. Available Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Cascade Waterworks Mfg.
    - c. GPT, Inc
- F. Grout:
  - 1. Consist of one part Portland cement, ASTM C150, Type I or II, three parts sand, and minimum amount of water to obtain desired consistency.
  - 2. Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles shall pass a No. 8 sieve and the material shall have a plasticity index of 12 or less.
  - 3. Compressive strength of 100 psi at 28-days.
- G. Controlled Low Strength Material:
  - 1. Ready mixed controlled low strength material is a blend of cement, fly ash, fine aggregate, and water. It is designed as a low strength, flowable material requiring no subsequent vibration or tamping to achieve 100% consolidation.
  - 2. Unless indicated otherwise, select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.
  - 3. Materials:
    - a. Cement: ASTM C150, Type I, II, or III.
    - b. Aggregate: ASTM C33, Size 8 or fine aggregate.
    - c. Fly Ash (if used): ASTM C618, Class C.
    - d. Water: Clean, potable, free of odor, organics, and deleterious materials.
  - 4. The flowable fill mixture shall be mixed either in a pug mill, concrete mixer, or transit mixer and shall a minimum slump of five (5) inches.
- H. Cellular Concrete Backfill:
  - 1. Concrete: ASTM C150, Type II.
  - 2. Foaming agents conform to ASTM C 869.
  - 3. Water: Clean, free of organic and other impurities.
  - 4. Minimum 7 and 28 day compressive strength of 300 and 500 psi.
- I. Annular Sand Backfill: Sand for the annular space shall be clean and 100% shall pass a Standard no. 30 sieve.
- J. Miscellaneous Items:
  - 1. Surface Settlement Markers:
    - a. Within bituminous pavement areas: "p.k." nails.
    - b. Within nonpaved areas: Wooden nails.

- c. Within concrete surfaces: Paint.
2. Grout Connections: Provide two inch grout connection regularly spaced at 5-foot centers, alternating at 30 degrees from plumb each side of the vertical centerline.
3. Bulkheads and Access Manholes: Requirements shall be as shown on the Drawings.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Unless soil borings in the immediate vicinity of the work area are available, CONTRACTOR shall investigate the existing soils and subsurface conditions so the appropriate equipment is provided to counter conditions, which can cause delay such as groundwater, running sand, boulders, or other subsurface conditions.

### 3.2 CONSTRUCTION BY JACKING

- A. Construct suitable pits or trenches at the jacking and receiving end to a depth no greater than required for placing of the guide and jacking timbers and a horizontal distance no nearer the roadbed than minimum distance shown on the Drawings. Excavation work shall comply with the requirements of Division 31 Section 31 05 00 "Earthwork Materials."
- B. All open pits and trenches shall braced and shored or their walls sloped preventing caving or sliding of the walls into the open pit or trench complying with requirements of Division 31 Section 31 23 16 "Excavation Support and Protection".
- C. Place pipe on guides for supporting pipe to be jacked and to direct it for proper alignment and grade. Embankment material shall be excavated just ahead of the pipe, removed through the pipe, and the pipe forced through the opening provided.
- D. Excavation for the underside of the pipe, for at least one-third (1/3) of the pipe circumference, shall conform to the contour and grade of the pipe. Excavation for the top half of the pipe shall conform closely to the outside diameter and a clearance greater than 2-inches shall not be permitted. Preferably pipe shall be jacked from the low or downstream end.
- E. All voids between the pipe and the earth shall be filled with grout. Provide grout holes in the pipe. The grouting shall follow immediately upon completion of the jacking operation. Prepare bottom of pits as pipeline foundations in accordance with Division 31 Section 31 23 33 "Trenching, Backfill, and Compaction". Backfill pits and trenches as soon as practical following completion of jacking operations and installation of carrier pipe(s).
- F. Any pipe that cannot be repaired to its original condition or is damaged during jacking operations shall be removed and replaced at CONTRACTOR'S expense.

### 3.3 CONSTRUCTION BY BORING

- A. Construct suitable pits or trenches at the boring and receiving end to a depth no greater than required for placing of the guide and jacking timbers and a horizontal distance no nearer the roadbed than minimum distance shown on the Drawings. Excavation work shall comply with the requirements of Division 31 Section 31 05 00 "Earthwork Materials."
- B. All open pits and trenches shall braced and shored or their walls sloped preventing caving or sliding of the walls into the open pit or trench complying with requirements of Division 31 Section 31 23 16 "Excavation Support and Protection".

- C. The hole shall be bored mechanically with a suitable boring assemble designed to produce a smooth, straight shaft and so operated that the completed shaft shall be at the established line and grade. The boring shall be accomplished using either a pilot hole method or a dry hole method.
  - 1. Pilot Hole Method: Bore approximately a 2-inch pilot hole the entire length of the crossing and confirm line and grade. The pilot hole shall serve as the centerline for the larger diameter hole to be bored.
  - 2. Dry Hole Method: Advance casing pipe as augers through the casing pipe remove the soil. Bentonite may be used as a lubricant.
- D. All voids between the pipe and the earth shall be filled with grout. Provide grout holes in the pipe. The grouting shall follow immediately upon completion of the jacking operation. Prepare bottom of pits and pipeline foundations in accordance with Division 31 Section 31 23 33 "Trenching, Backfill, and Compaction". Backfill pits and trenches as soon as practical following completion of jacking operations and installation of carrier pipe(s).
- E. Any pipe that cannot be repaired to its original condition or is damaged during boring operations shall be removed and replaced at CONTRACTOR'S expense.

### 3.4 CARRIER PIPE INSTALLATION

- A. Installation:
  - 1. Install carrier pipe to establish lines and grades.
  - 2. Carrier pipe joints within the casing pipe shall be of the restrained type in accordance with applicable pipe specifications. If applicable, exterior and interior joints of the carrier pipe shall be mortar coated and lined in the field as installation progresses.
  - 3. For cast iron or ductile iron, encase pipe in polyethylene in accordance with applicable pipe section.
  - 4. Install casing spacers by placing at each end of the casing pipe and at 6 to 8 feet intervals, and in accordance with manufacturer instructions. There shall be at least two spacers installed on each pipe section.
  - 5. Seal ends of casing and carrier pipe using neoprene casing end seals and stainless steel bands. If overlap seal is employed, bond together the overlapping surfaces with permanent sealing adhesive.
- B. Testing: Hydrostatic testing of the carrier pipe shall be completed prior to the filling of the annular space between the casing and carrier pipe. Testing shall be accomplished in accordance with the applicable pipe section.
- C. Supports: Carrier pipe shall be supported to the quarter point by a concrete cradle across the boring or jacking pit to the first joint in the ditch section at each end.
- D. Additional Pipes or Conduits: Where more than one pipe or conduit, such as irrigation or communication/electrical cables or conduits, in addition to the primary carrier pipe, is shown inside the casing, they shall be bundled and attached to special multiple pipe cluster type spacers as a unit in the quadrant shown on the Drawings.

### 3.5 CONSTRUCTION BY GUIDED BORING OR DIRECTIONAL DRILLING

- A. Guided boring or directional drilling shall be accomplished according to the standards in "Trenchless Technology Guidelines" published by International Society of Trenchless Technology.

### 3.6 CONSTRUCTION BY TUNNELING

- A. The tunnel shall be excavated in such a manner and to dimensions necessary to permit placement of supports for excavation. Adequate provisions shall be made for the safety, health, and protection of workers. All equipment operated in tunnel shall be powered by air or electricity. No equipment shall be permitted in tunnel powered by petroleum-based fuel.
- B. Tunnel dimensions shown on Drawings are minimum dimensions. Any excess excavation and subsequent backfill, concrete or grout fill shall be at the expense of the CONTRACTOR.
- C. Provide lighting and ventilation, quick removal of gasses and dust from operations, and means for removal of spoils from the excavations.
- D. Provide suitable steel or timber sheeting, shoring and bracing in accordance with Division 31 Section 31 23 33 "Trenching, Backfill, and Compaction". When installation is complete and with approval of ENGINEER, supports may be left in place, provided they clear the encasement or carrier pipe. No separate payment shall be made for supports left in place.
- E. If the tunnel is to be lined with concrete as a monolithic structure, then the overbreak, if any or voids shall be poured with 4,000 psi concrete.
- F. Install carrier pipe in tunnel to established line and grade. As specified, fill the void space between the carrier pipe and tunnel walls or inside face of tunnel lining with annular sand, cellular concrete or flowable fill.

### 3.7 FIELD QUALITY CONTROL

- A. Grade and Alignment. Provide field survey data confirming grade and alignment conforms to values shown on the Drawings and within limits of specified in this Section.
- B. Provide test data for materials used in installing casing and carrier pipe, such as grout, concrete, flowable fill, cellular concrete fill, and sand used to fill annular space between carrier pipe and casing.
- C. Provide settlement measurements. During construction, make observations of settlement markers at regular intervals of roadway and railroad tracks. Record and provide information.

**END OF SECTION**



**SECTION 32 31 19**  
**CHAIN-LINK FENCES AND GATES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section specifies the requirements for chain-link fences and gates.

**1.2 REFERENCE STANDARDS**

A. ASTM International (ASTM):

1. A121 – Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
2. A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
3. A817 – Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire
4. A824 – Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
5. C33 – Standard Specification for Concrete Aggregates
6. C150 – Standard Specification for Portland Cement
7. F567 – Standard Practice for Installation of Chain-Link Fence
8. F626 – Standard Specification for Fence Fittings
9. F668 – Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric
10. F900 – Standard Specification for Industrial and Commercial Steel Swing Gates
11. F1043 – Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
12. F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
13. F1184 – Standard Specification for Industrial and Commercial Horizontal Slide Gates

B. Chain Link Fence Manufacturers Institute (CLFMI):

1. CLF 2445 – Chain Link Fence Manufacturers Institute Product Manual

C. National Fire Protection Association (NFPA):

1. NFPA 70 – Article 100

D. UL Standard (UL):

1. UL 325 – Safety Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems
2. UL 467 – Grounding and Bonding Equipment

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

## 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. UL Standard: Provide gate operators that comply with UL 325.
- C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

## 1.5 DEFINITIONS:

- A. Posts: Vertical members of the fence.
  - 1. End, corner, and pull posts are posts at which chain link fence terminates.
  - 2. Gate posts are posts at which gates are either attached or latched.
  - 3. Line posts are posts that occur in a line of fence in which the chain link fabric passes and to which it is tied.
- B. Rails: Horizontal members of the fence; may be top, bottom, intermediate or brace rails.

## PART 2 - PRODUCTS

### 2.1 CHAIN-LINK FENCE FABRIC

- A. General: Height indicated on Drawings. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:
  - 1. Steel Wire Fabric: Metallic-coated wire with a diameter of 0.148 inch (9 gauge).
    - a. Mesh Size: 2 inches.
    - b. Metallic (Zinc) Coating: ASTM A 392, Class II, 2.0 oz./sq. ft., minimum.
  - 2. Selvage: Knuckled at both selvages for fabrics less than 6-feet high. Twisted top and knuckled bottom for fabrics 6-feet and higher.

### 2.2 INDUSTRIAL FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 and the following:
  - 1. Material Group: IA, round steel pipe, Schedule 40, or 1C steel pipe.
  - 2. Fence Height: 8 feet as shown on drawings.
  - 3. Strength Requirement: Heavy industrial according to ASTM F 1043, Table 3.
  - 4. Horizontal-Slide Gate Post: According to ASTM F 1184.
  - 5. Minimum Sizes (Outside Diameter):
    - a. Rail or braces: 1.625-inches.
    - b. Line Post: 2.375-inches.
    - c. End, Corner, and Terminal Posts: 2.875-inches.
    - d. Gate Posts:
      - 1) Gate Leaf Width, 12-feet or less: 4.000-inches.
      - 2) Gate Leaf Width, over 12-feet to 18-feet: 6.625-inches.
      - 3) Gate Leaf Width, over 18-feet to 24-feet: 8.625-inches.
  - 6. Coating for Steel Framing:

- a. Metallic coating, 2.0 oz./sq. ft. minimum.

## 2.3 TENSION WIRE

- A. General: Provide horizontal tension wire at top and bottom of fence fabric. If fence has a top rail, top tension wire not required.
- B. Metallic-Coated Steel Wire: 0.177-inch- diameter (#7 gage), marcelled tension wire complying with ASTM A 817 and ASTM A 824.

## 2.4 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F 900 for single or double swing gate types as indicated on Drawings.
  - 1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.
- B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:
  - 1. Gate Fabric Height: 2 inches less than adjacent fence height.
  - 2. Leaf Width: As shown on Drawings.
  - 3. Frame Members:
    - a. Tubular Steel: 1.90 inches round.
- C. Frame Corner Construction:
  - 1. Welded or assembled with corner fittings and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.
- D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach barbed wire assemblies.
- E. Hardware: Latches permitting operation from both sides of gate, two 180-degree hinges per leaf, center gate stop and drop rod for double gates, mechanical keepers for each gate leaf more than 5 feet wide, and hardware for padlock.

## 2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Finish:
  - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 2.0 oz. /sq. ft. zinc.
  - 2. Aluminum: Mill finish.

## 2.6 BARBED WIRE

- A. Zinc-Coated Steel Barbed Wire: Comply with ASTM A 121; 2-point round barbs spaced not more than 5 inches o.c.

## 2.7 CAST-IN-PLACE CONCRETE

- A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water.
  - 1. Concrete Mixes: Normal-weight concrete with not less than 3000-psi compressive

strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

## 2.8 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - 1. Material above Finished Grade: Copper.
  - 2. Material on or below Finished Grade: Copper.
  - 3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Connectors and Grounding Rods: Comply with UL 467.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing's indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
- D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment.
- E. Line Posts: Space line posts uniformly at 10 feet o.c., unless otherwise shown on Drawings.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567. Install braces at end and gate posts and at both sides of corner and pull posts.
- G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing.
- H. Top Rail: When indicated on Drawings, install according to ASTM F 567.
- I. Bottom Rails: When indicated on Drawings, install, spanning between posts.
- J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.
- K. Tie Wires: Attach wire per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
- L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- M. Privacy Slats: When indicated on Drawings install slats in direction indicated, securely locked in place.
- N. Privacy Screen: When indicated on Drawings, install polyethylene screen to chain-link fabric, securely locked in place.
- O. Barbed Wire: When indicated on Drawings, install barbed wire uniformly spaced, angled

toward security side of fence. Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

### 3.2 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

### 3.3 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet, unless otherwise specified.
- B. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet, unless otherwise specified.
  - 1. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.
- C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
  - 1. Connections: Make connections so possibility of galvanic action or electrolysis is minimized.
- D. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

### 3.4 FIELD QUALITY CONTROL

- A. Grounding-Resistance Testing: Engage a qualified independent testing agency to perform field quality control testing.

**END OF SECTION**

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**SECTION 32 91 19  
LANDSCAPE GRADING**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Finish grade subsoil.
- B. Furnish place, level, and compact topsoil in areas to receive sod as specified in Section 32 92 24 – Hydromulch Seeding and Sodding.

**1.2 PROTECTION**

- A. Protect landscaping and other features remaining as final work.
- B. Protect existing structures, fences, roads, sidewalks, paving, and curbs.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Topsoil: Topsoil shall be stripped and stockpiled for reuse on this project.
- B. Topsoil: Natural friable loam; free of subsoil, roots, grass, excessive amount of weeds, stone, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 4 percent and a maximum of 25 percent organic matter.

**PART 3 - EXECUTION**

**3.1 INSPECTION**

- A. Verify site conditions and note irregularities affecting work of this Section.
- B. Beginning work of this Section means acceptance of existing conditions.

**3.2 SUBSOIL PREPARATION**

- A. Eliminate uneven areas and low spots. Finish grade uniformly to maintain contours shown. Make gradual grade changes blending slopes into level areas. Create drainage swales and berms as shown on the Plans. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove subsoil contaminated with petroleum products.
- B. Scarify subgrade to depth of 4 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

**3.3 PLACING TOPSOIL**

- A. Place topsoil in areas where seeding, sodding, plugging or planting is scheduled.
- B. Use topsoil in relatively dry state. Place during dry weather.
- C. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.
- D. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.
- E. Manually spread topsoil around trees, plants and buildings.
- F. Lightly compact roll placed topsoil.

G. Leave stockpile area and site clean and raked, ready to receive landscaping.

#### 3.4 TOLERANCES

A. Uniformity of Topsoil: Plus or minus 1-inch.

#### 3.5 SCHEDULE OF LOCATIONS

A. The following list identifies compacted topsoil thicknesses for various locations.

1. Seeded Grass: 6 inches.
2. Sod: 4 inches.
3. Shrub Beds: 18 inches.
4. Flower Beds: 12 inches.
5. Planter Boxes: To within 3 inches of box rim.

**END OF SECTION**



**SECTION 32 92 24**  
**HYDROMULCH SEEDING AND SODDING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Section Includes:**

1. Hydromulch seeding of grass is required as shown on the Plans and all areas disturbed by construction activities. Establishment of a uniform, full-coverage of grass is required in all disturbed areas, and other areas indicated on the Plans. Hydromulch seeding is specified for these areas where grass establishment is required.
2. Hydromulch seeding includes mixing fertilizer, grass seed and mulch material with water and spraying the mixture onto tilled topsoil. Seeding includes spreading fertilizer, and grass seed onto tilled topsoil.
3. Furnish all materials, labor and equipment including watering system to establish full coverage grass where specified and to maintain the established areas for 60 days.
4. Bermuda sodding is required for a 3-foot-wide strip adjacent to all structures, on either side of all new roadways and sidewalks, and along existing pavement, sidewalks and structures where the area was disturbed by construction.

**1.2 DEFINITIONS**

- A. Weeds:** Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

**1.3 SYSTEM DESCRIPTION**

**A. Design Requirements:**

1. Comply with ODAFF General Permit No. OKG87A000.

**B. Performance Requirements:**

1. In the designated areas for grass establishment, it shall be the sole responsibility of the CONTRACTOR to establish uniform stand of grass which is defined as not less than 150 growing plants per square foot of seeded area, regardless of adverse climatic or other conditions. The OWNER may stop work if unfavorable conditions are likely until favorable conditions are present.

**1.4 SUBMITTALS**

**A. Product Data:**

1. Submit data on fertilizer, seed, and mulch as necessary to show compliance with these specifications. Include source of supply for materials as well as:
  - a. Name, trademark, warranty, analysis, form, and coverage for fertilizer.
  - b. Name, type, germination, purity, germination test results with date of test for seed.
  - c. Name, type, components, and coverage for mulch.

**B. Shop Drawings:**

1. Submit maintenance instructions, cutting method, minimum and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

#### 1.5 QUALITY ASSURANCE

- A. Provide seed in containers showing name and type of seed, year of production, net weight, date of packaging, date of germination test, and location of packaging.
- B. Provide fertilizer in containers bearing the name, trademark warranty of producer, the weight and analysis, and form of constituents.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged, wet, or moldy packaging is not acceptable. Store in dry location.
- B. Deliver fertilizer in waterproof bags. Store in dry location not in contact with runoff.

#### 1.7 PROJECT CONDITIONS (NOT USED)

#### 1.8 WARRANTY (NOT USED)

#### 1.9 EXPERIENCE REQUIREMENTS (NOT USED)

#### 1.10 MAINTENANCE

- A. Maintenance Service:
  1. For areas where establishment is required per the Plans and per Paragraph 1.03.B.1, maintain the hydromulched areas for the term of the Contract plus 60 days following Final Completion beginning immediately after placement and watering as required until grass is well established and exhibits a vigorous growing condition. Coordinate water requirements with availability of water from OWNER and areas to be seeded at one time.

### PART 2 - PRODUCTS

#### 2.1 SEED MIXTURE

- A. Seed Type: Hulled extra fancy grade, common Bermuda (*Cynodon dactylon*).
- B. Seed Quality:
  1. All seed shall meet the requirements of the Oklahoma Seed Law including labeling requirements for showing pure live seed (PLS = purity x germination), name and type of seed. All seed shall be treated with a fungicide. Seed, which has become wet, moldy or otherwise damaged in transit or storage, will not be acceptable. Seed shall be new crop seed (harvested within 1 year prior to planting), free of other weed seed to the limits allowable under the Oklahoma Seed Law. The seed shall have a germination and purity that will produce a pure live seed content of not less than 85 percent.

#### 2.2 FERTILIZER

- A. Fertilizer shall be a commercial product uniform in composition, free flowing, and suitable for application with standard equipment. The fertilizer shall comply with the applicable State fertilizer laws and shall be delivered in bags or other convenient containers, each fully

labeled and bearing the name, trademark, and warranty of the producer. Fertilizer applied during the initial planting shall have analysis ratio of 20-20-20 also containing traces of sulfur, iron and zinc. Fertilizer used in the second application shall have an analysis ratio of 12-4-8. The figures in the analysis represent the percent of nitrogen, phosphorus, and potash nutrients, respectively as determined by methods of the Association of Official Agricultural Chemists. Fifty percent or greater of the nitrogen required shall be in the form of nitrate nitrogen. The remaining nitrogen may be in the form of urea nitrogen.

- B. In the event it is necessary to substitute a fertilizer of a different analysis or form, the total amount of nutrients applied per 1000 square feet shall equal or exceed that specified for each nutrient.
- C. Fertilizer which has become caked or exposed to excess humidity or mixture will not be acceptable.

### 2.3 HYDROMULCH

- A. Hydromulch material for areas requiring grass establishment shall be Second Nature Hydroseeding Mulch as manufactured by Central Fiber Corporation, or approved equivalent. Mulch shall be manufactured of natural fiber stock free of plastics and foreign materials. Mulch shall have a green non-toxic dye, disperse rapidly in water to form a homogeneous slurry and shall remain in suspension. It shall have a water holding capacity of not less than 1300 gms water per 100g fiber.

### 2.4 MULCH:

- A. Furnish straw mulch free of weeds and spread at the recommended rate to adequately cover all areas which are broadcast seeded and indicated to be mulched.

### 2.5 SOIL MATERIALS

- A. Topsoil: Topsoil shall be 4 inches in depth. Refer to material requirements in Section 31 05 00 "Earthwork Materials."

### 2.6 ACCESSORIES

- A. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass. Plant effluent may be used.
- B. Erosion Fabric: Jute matting, open weave, where shown on Plans or where slope is steeper than 3:1.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify that prepared soil base is ready to receive the work of this Section that topsoil has been placed and final grading is acceptable to OWNER.
- B. Beginning of installation means acceptance of existing site conditions.

### 3.2 FINAL GRADING

- A. Comply with the requirement in Section 32 91 19 "Landscape Grading" for final grading, subsoil preparation and placement of topsoil prior to seeding. All areas to be seeded shall have sufficient topsoil placed prior to seeding.

- B. Smooth areas that have become gullied; and loosen or retil areas that have become compacted since completion of grading to a depth of 6 inches.

### 3.3 FERTILIZING

- A. Apply initial fertilizer in accordance with manufacturer's instructions at a minimum rate of 15 lb per 1000 sf with hydromulch mixture.
- B. A second application of fertilizer shall be applied to the establishment areas between 45 and 60 days from seeding, at a rate of 8 pounds per 1000 sf.

### 3.4 SEEDING

- A. For hydromulch (grass establishment) areas, hydromulch mixture containing the seed, fertilizer, mulch and water shall be prepared in accordance with the following quantities. Mixture shall be applied to planting area using conventional "Hydromulch" equipment. For seeded areas, seed and fertilizer shall be spread with mechanical spreaders to obtain the specified rates.

<b>Component</b>	<b>Rate per 1000 sf</b>
Grass seed	2.5 pounds
Fertilizer	15 pounds
Water	As Needed
Paper Fiber	As recommended by
Mulch	manufacturer

- B. Planting Season:
  1. March 1 to August 31.
  2. Seeding shall not be done during periods other than listed above.
- C. For areas to be established, apply water with a fine spray immediately (within 24 hours) after each area has been seeded and mulched. Saturate to 4 inches of soil. Water daily as often as necessary for 4 weeks to establish grass.

### 3.5 SEED PROTECTION

- A. Cover seeded slopes where grade is steeper than 4 inches per foot with erosion fabric. Roll fabric onto slopes without stretching or pulling. Cover hydromulched areas as recommended to obtain establishment of grass.
- B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 12-inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.
- C. Secure outside edges and overlaps at 36-inch intervals with stakes.
- D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.
- F. No heavy equipment shall be moved over planted area unless area is to be retilled and reseeded.

### 3.6 MAINTENANCE FOR HYDROMULCHED AREAS

- A. The CONTRACTOR shall mow grass as required.
- B. CONTRACTOR shall water as required to establish grass and to prevent grass and soil from drying out for the initial 60-day period.
- C. CONTRACTOR shall control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- D. Prior to the second fertilizer application, CONTRACTOR shall reseed areas which show bare spots of 2 square feet or larger. Minimum of 95 percent coverage shall be required for OWNER acceptance.
- E. CONTRACTOR shall maintain grass and reseed as required to establish 95 percent coverage (within a minimum of 60 days) or 150 plants per square foot.
- F. Protect seeded areas with warning signs during maintenance period, if necessary.

**END OF SECTION**

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**SECTION 33 05 07.13**  
**HORIZONTAL DIRECTIONAL DRILLING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This work shall include equipment, materials, and labor for the complete and proper installation of underground Fused PVC pipe utilizing using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring. This shall also include all testing, restoration of underground utilities, and erosion and sedimentation control and restoration.

**1.3 REFERENCES AND DEFINITIONS**

- A. References:
  - 1. ASTM International (ASTM):
    - a. D1784 Specification for Rigid PVC Compounds and Chlorinated PVC Compounds
    - b. D2152 Test Method for Degree of Fusion of Extruded PVC Pipe and Molded Fittings by Acetone Immersion
    - c. D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
    - d. D3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
    - e. F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pressure Pipe
  - 2. American Water Works Association (AWWA):
    - a. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-inch through 48-inch (100 mm through 1200 mm), for Water Distribution
  - 3. Related Specification Sections include, but are not necessarily limited to:
    - a. Division 01 General Requirements
    - b. Section 33 05 31.23 Piping System, Fusible PVC Pipe

**1.4 PERFORMANCE REQUIREMENTS**

- A. Quality Assurance: The requirements set forth in this document specify a wide range of procedural precautions necessary to provide the very basic, essential aspects of a proper directional bore installation and are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the ENGINEER approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the CONTRACTOR of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

1. Installer's Qualifications: Installation shall be by a competent, experienced CONTRACTOR or SUB-CONTRACTOR. The installation CONTRACTOR shall have a satisfactory experience record of at least 3 years engaged in similar work of equal scope. If patented processes are involved based on the pipe selection, the installer shall be licensed, trained and in good standing with the pipe manufacturer.
2. Performance Requirements: Lateral or vertical variation in the final position of the carrier pipe from the line and grade established by the plans shall be permitted only to the extent of 4 percent, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe.
3. Certification: Pipe products shall have been tested and approved by an independent third-party laboratory for continuous use at rated pressures.
4. Design Criteria: The maximum allowable load for PVC pipe installations shall produce a maximum deflection of 4 percent.

## 1.5 SUBMITTALS

### A. Submittals shall include:

1. Work Plan: Prior to beginning work, the CONTRACTOR shall submit to the ENGINEER a work plan as record data detailing the procedure and schedule to be used to execute the project. The work plan should include a description of all equipment to be used, down-hole tools, a list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable), list of sub-contractors, a schedule of work activity, a safety plan (including MSDS of any potentially hazardous substances to be used), traffic control plan (if applicable), all excavation locations, interfering utilities, and flow bypass, an erosion and sedimentation control plan and contingency plans for possible problems. Work plan should be comprehensive, realistic and based on actual working conditions for the project.
2. Equipment: CONTRACTOR will submit specifications on directional drilling equipment as record data. Equipment shall include but not be limited to: drilling rig, butt fusion welding apparatus, mud system, mud motors (if applicable), down-hole tools, guidance system, rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that CONTRACTOR intends to use or might use will be submitted.
3. Material: Provide shop drawings of the pipe with material specifications, including size, type, diameter and manufacturer's data and certifications on piping and jointing methods. The shop drawing shall include a Certificate of Adequacy of Design stating the pipe and fittings are satisfactory for the loads which will be imposed during for all loading conditions.
4. CONTRACTOR shall maintain a daily project log of drilling operations and a guidance system log along with a fusion report for all butt fused welding of joints with a copy given to ENGINEER and INSPECTOR at completion of project.

## 1.6 DELIVERY AND STORAGE

- A. Store PVC pipe material so that there is no exposure to sunlight.

## 1.7 JOB CONDITIONS; PERMIT AND EASEMENT REQUIREMENTS

- A. Where the work is in the public right-of-way the CONTRACTOR will secure the appropriate



permits or easements. The CONTRACTOR shall observe regulations and instructions of the right-of-way Owner as to the methods of performing the work and take precautions for the safety of the property and the public. Negotiations and coordination with the right-of-way Owner shall be carried on by the CONTRACTOR, not less than 5 days prior to the time of his intentions to begin work on the right-of-way.

- B. Comply with the requirements of the permit and/or easement. If required by the Right-of-Way Owner, obtain Protective Liability Insurance.
- C. Construction along roads and public areas shall be performed in such manner that does not interfere with the operations of the roads.
- D. Barricades, warning signs, and flagmen, when necessary and specified, shall be provided by the CONTRACTOR.
- E. No blasting shall be allowed.
- F. Existing pipelines and underground conduits are to be protected. The CONTRACTOR shall verify location and elevation of any pipelines, telephone cable and fiber optics before proceeding with the construction and shall plan his construction so as to avoid damage to the existing pipe lines or telephone cables. Verification of location (vertical and horizontal) of existing utilities shall be the complete responsibility of the CONTRACTOR.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General:
  - 1. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the crossing, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system.
  - 2. All equipment shall be in good, safe operating condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of this project.
  - 3. Fusible PVC pipe shall be supplied per Section 33 05 31.23, Fusible PVC Pipe.
- B. Drilling System:
  - 1. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pullback operations. The rig shall be grounded during drilling and pull-back operations. There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.
  - 2. Drill Head: The drill head shall be steerable by changing its rotation and shall provide the

necessary cutting surfaces and drilling fluid jets.

3. Pressure Tool: A pressure tool shall be used on the drill stem for the pilot hole, and monitored by the Mud Engineer to mitigate Inadvertent Releases from occurring.
4. Mud Motors (if required): Mud motors shall be of adequate power to turn the required drilling tools.
5. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

C. Guidance System:

1. A Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to 100 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to plus or minus 2 percent of the vertical depth of the bore hole at sensing position at depths up to 100 feet and accurate within 1.5 meters horizontally.
2. The Guidance System shall be of a proven type and shall be operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.

D. Drilling Fluid Mud System:

1. Mixing System: A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. The drilling fluid reservoir tank shall be of sufficient size for making the bore. Mixing system shall continually agitate the drilling fluid during drilling operations.
2. Drilling Fluids: Drilling fluid shall be composed of clean water and appropriate additives. Water shall be from an authorized source with a pH of 8.5 to 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No potentially hazardous material may be used in drilling fluid.
3. Delivery System: The mud pumping system shall have a minimum capacity to maintain correct boring alignment and be capable of delivering the drilling fluid at a constant pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12 inches high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.
4. Drilling Fluid Recycling System: The drilling fluid recycling system shall separate sand, dirt, and other solids from the drilling fluid to render the drilling fluid reusable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

E. Other Equipment:

1. Pipe Rammers: Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of ENGINEER. The ENGINEER or Inspector must be onsite when a

pipe rammer is used.

2. Restrictions: Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the ENGINEER prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the conditions of the project.

F. Piping Materials:

1. Sanitary Sewer Force Main:

- a. Pipe Material: C900 CLASS 235 (DR-18) – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-inch through 48-inch (100 mm through 1200 mm)
- b. Pipe Markings: Pipe shall be legibly marked in permanent ink with the manufacturer and trade name, nominal size and DR rating/pressure class, hydrostatic proof test pressure, manufacturer date code.

2. Tracer Wire: Tracer wire shall be Copperhead Industries and shall be rated for horizontal directional drilling applications.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. The ENGINEER and Inspector must be notified 48 hours in advance of starting work. The Directional Bore shall not begin until the Inspector is present at the job site and agrees that proper preparations for the operation have been made.
- B. The approval for beginning the installation shall in no way relieve the CONTRACTOR of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract.

#### 3.2 PERSONNEL REQUIREMENTS

- A. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. The operator of the drilling rig must have at least 3 years directional drilling experience. A responsible representative who is thoroughly familiar with the equipment and type work to be performed, must be in direct charge and control of the operation at all times. In all cases the supervisor must be continually present at the job site during the actual Directional Bore operation. The CONTRACTOR shall have a sufficient number of competent workers on the job at all times to ensure the Directional Bore is made in a timely and satisfactory manner.
- B. Mud Engineer: The CONTRACTOR shall have a trained Mud Engineer with at least 3 years engaged in similar work of equal scope. The Mud Engineer shall be present for the pilot hole and all subsequent ream bores. The pilot drill pressures shall be monitored by the Mud Engineer using a pressure tool placed on the drill stem, in order to mitigate any occurrences of Inadvertent Releases. The pressure tool is not required on subsequent reamer passes.

#### 3.3 DRILLING PROCEDURES

- A. Site Preparation: Prior to any alterations to work-site, CONTRACTOR shall photograph or video tape entire work area, including entry and exit points, one copy of which shall be given to INSPECTOR and one copy to remain with CONTRACTOR for a period of 1 year following the completion of the project. Work sites shall be within right-of-way and shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. CONTRACTOR shall confine all activities to designated work areas.
- B. Drill Path Survey: Entire drill path shall be accurately surveyed by the CONTRACTOR with entry and exit stakes placed in the appropriate locations within the areas determined in the field with the INSPECTOR. Locate existing utilities in advance of boring operations. The CONTRACTOR shall be responsible for repairing damage to existing utilities at no additional cost to the Owner. Repair of existing utilities shall proceed until complete and the existing utility is back in service. If CONTRACTOR is using a magnetic guidance system, drill path shall be surveyed by the CONTRACTOR for any surface magnetic variations or anomalies.
- C. Environmental Protection: CONTRACTOR shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. CONTRACTOR shall adhere to all applicable environmental regulations. Fuel may not be stored in bulk containers within 200 feet of any water-body or wetland.
- D. Safety: CONTRACTOR shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner.
- E. Pilot Hole:
  - 1. Pilot hole shall be drilled on bore path with no deviations greater than 4 percent horizontally or vertically over a length of 100 feet. If pilot hole does deviate from bore path more than 4 percent, CONTRACTOR shall notify ENGINEER, who may require CONTRACTOR to pull-back and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, CONTRACTOR shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a Marsh funnel and then wait another 30 minutes.
  - 2. If mud fracture or returns loss continues, CONTRACTOR will cease operations and notify the ENGINEER. The ENGINEER and CONTRACTOR will discuss additional options and work will then proceed accordingly.
  - 3. Reaming: Upon successful completion of pilot hole, CONTRACTOR will ream bore hole to a minimum of 25 percent greater than outside diameter of pipe using the appropriate tools. CONTRACTOR will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.
- F. Pull-Back:
  - 1. After successfully reaming bore hole to the required diameter, CONTRACTOR will pull the pipe through the bore hole. In front of the pipe will be a swivel and reamer to compact bore hole walls. Pull loads shall not exceed the limits shown in the following tables. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole.
  - 2. During pull-back operations CONTRACTOR will not apply more than the maximum safe

pipe pull pressure at any time. In the event that pipe becomes stuck, CONTRACTOR will cease pulling operations to allow any potential hydro-lock to subside and will recommence pulling operations. If pipe remains stuck, CONTRACTOR will notify Inspector to discuss options and then work will proceed accordingly.

### 3.4 FUSIBLE PVC JOINING

- A. The pipe shall be assembled and joined at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of the pipe and/or fusing equipment.
- B. The butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from the outside surface such that the joint surfaces shall be smooth. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Inspector prior to insertion. All defective joints shall be cut out and replaced at no cost to the Owner. Any section of the pipe with a gash, blister, abrasion, nick, scar or other deleterious fault greater in depth than 5 percent of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the INSPECTOR shall be discarded and not used.
- C. Terminal sections pipe that are joined within the insertion pit shall be connected with a fully restrained solid sleeve. The butt gap between pipe ends shall not exceed 1/2 inch.

### 3.5 PIPE TESTING

- A. Following successful pull-back of pipe, CONTRACTOR will test pipe using potable water according to the City's requirements. A calibrated pressure recorder will be used to record the pressure during the test period. This record will be submitted to ENGINEER.

### 3.6 SITE RESTORATION

- A. Following drilling operations, CONTRACTOR will de-mobilize equipment and restore the worksite to original condition. All excavations will be backfilled and compacted to 95 percent of original density.

**END OF SECTION**

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**SECTION 33 05 30**  
**PIPING SYSTEMS, HANGERS AND SUPPORTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Work covered under this Section consists of providing hangers and supports for equipment and piping systems.
- B. Related Sections:
  - 1. SECTION 05 50 00 - METAL FABRICATIONS for materials for attaching hangers and supports to structures and buildings.
  - 2. SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for requirements for supporting electrical systems.

**1.3 DEFINITIONS AND REFERENCES**

- A. Definition:
  - 1. Wetted or Submerged: Submerged, less than one foot above liquid, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.
- B. References:
  - 1. American Welding Society (AWS):
    - a. D1.1 – Structural Welding Code-Steel
    - b. D1.2 - Structural Welding Code-Aluminum
    - c. D1.6 - Structural Welding Code-Stainless Steel
  - 2. American Society of Mechanical Engineers:
    - a. B31.9-Standard Building Services Piping
    - b. Section IX, Boiler and Pressure Vessel Code: Welding and Brazing Qualifications
  - 3. ASTM International (ASTM):
    - a. B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
    - b. A 36-Standard Specifications for Carbon Structural Steel
    - c. A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
    - d. A 183 – Specification for Carbon Steel Track Bolts and Nuts
    - e. A 525 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
    - f. A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    - g. A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip galvanized Coatings.
    - h. A 1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, high-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability,

- and Ultra-High Strength
- i. C 1107 – Specification for Packaged Dry Hydraulic Cement (Non-Shrink)
- j. F 844 –Specification for Washers, Steel, Plain (Flat), Unhardened for General Use Only
- 4. Manufacturers Standardization Society (MSS):
  - a. SP-58 Pipe Hangers and Supports-Materials, Design and Maintenance
  - b. SP-69 Pipe Hangers and Supports-Selection and Application
  - c. SP-89 Pipe Hangers and Supports-Fabrication and Installation Practices
  - d. SP-127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
- 5. NFPA (National Fire Protection Association):
  - a. NFPA 13 – Standard for the Installation of Sprinkler Systems
  - b. NFPA-14 - Standard for the Installation of Standpipes and Hose Systems
  - c. NFPA 70 - National Electrical Code

#### 1.4 SYSTEM DESCRIPTION

- A. Engineered Hanger and Support System: The Contractor shall provide an engineered hanger and support system for the various piping systems indicted on the Drawings. This includes the design of multiple piping supports and trapeze hangers and the selection of appropriate hangers and anchors to the structures, buildings, and facilities. This design shall be accomplished by a professional engineer license in the state where the Project is to be constructed.
- B. Codes and Standards:
  - 1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of the hanger and support system.
  - 2. NFPA Compliance: Hanger and support system shall comply with NFPA -13 when used as a component of a fire protection system and NFPA-14 when used as a component of a standpipe system.
  - 3. UL and FM Compliance: Hanger and support system components shall be listed and labeled by UL and FM when used for fire protection systems.
  - 4. National Recognized Testing Laboratory and NEMA Compliance (NRTL): Instead of UL and FN compliance, the hanger and support system components shall be listed and labeled by a NTRL where used for fire protection systems. The term “NTRL” shall be as defined in OSHA Regulation 1910.7.
  - 5. Duct Hangers: SMACNA Duct Manuals.
  - 6. MSS Standard Compliance: Provide hanger and support system components of which materials, design, and manufacture comply with MSS SP-69.
- C. Design Requirements:
  - 1. General:
    - a. The configuration and layout of yard and station piping systems are shown in the Drawings.
    - b. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint.



- c. It shall be the Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to provide restraints and anchor all piping, in accordance with the requirements set forth herein.
  - d. Additional pipe supports may be required adjacent to expansion joints, couplings, flanged connections, or valves.
  - e. Piping smaller than 30 inches: Supports are shown only where specific types and locations are required; provide additional pipe, valve, and equipment supports as required.
  - f. Piping 30 inches and Larger: Support systems have been designed for piping and shall be placed at the designated locations as shown on the Drawings
  - g. Comply with the requirements of MSS SP-58, MSS SP-69, and MSS SP-89.
2. Piping Support Systems:
- a. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.
  - b. Safety Factor: Minimum of 5. Maximum Support Spacing and Minimum Rod Size:
    - 1) Steel or Ductile Iron Piping:

<b>Table 1 Steel or Ductile Iron Pipe</b>		
<b>Pipe Size</b>	<b>Maximum Support/Hanger Spacing</b>	<b>Minimum Rod Size Single Rod Hangers</b>
1-inch and smaller	6 feet	1/4-inch
1-1/2-inch thru 2-1/2-inch	8 feet	1/4-inch
3-inch & 4-inch	10 feet	3/8-inch
6-inch	12 feet	3/8-inch
8-inch	12 feet	1/2-inch
10-inch & 12-inch	14 feet	5/8-inch
14-inch	16 feet	3/4-inch
16-inch & 18-inch	16 feet	7/8-inch
20-inch	18 feet	1-inch
24-inch	18 feet	1-1/4-inch
30-inch and larger	As shown on Drawings	As shown on Drawings

- 2) Copper Piping:
  - a) Maximum Support Spacing: Two (2) feet less per size than listed for steel, with 1-inch and smaller pipe supported every five (5) feet.
  - b) Minimum Hanger Rod Size: Same as listed for steel pipe.
- 3) Plastic and Fiberglass Piping:
  - a) Maximum Support Spacing: As recommended by manufacturer for flow and temperature in pipe.
  - b) Minimum Rod Sizing: Same as listed for steel pipe.
  - c) Provide supports with width as required by pipe manufacturer and shields as required to protect pipe in accordance with manufacturer's requirements.

4) Stainless Steel Piping:

<b>Table 2 Stainless Steel Pipe</b>		
<b>Pipe Size</b>	<b>Maximum Support/Hanger spacing</b>	<b>Minimum Rod Size Single Rod Hangers</b>
1-inch thru 4-inch	8 feet	1/4-inch
6-inch	8 feet	3/8-inch
8-inch & 10-inch	10 feet	1/2-inch
12-inch	10 feet	1/2-inch
14-inch & 16-inch	12 feet	5/8-inch
18-inch & 20-inch	14 feet	3/4-inch
24-inch	14 feet	7/8-inch

3. Framing Support Systems:
  - a. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
  - b. Column Members: Size in accordance with manufacturer's recommended method.
  - c. Support Loads: Calculate using weight of pipes filled with water.
  - d. Maximum Spans:
    - 1) Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.
    - 2) Other Pipelines and Special Situations: May require supplementary hangers and supports.
  - e. Electrical Conduit Support: Include in design of framing support systems.
4. Anchoring Devices: Design, size, and pace support devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
5. Vertical Sway Bracing: 10-foot maximum centers, or as shown.
6. Existing Support Systems: use existing support systems to support new piping only if Contractor can show that they are adequate for the additional loads, or if they are strengthened to support the additional load.

## 1.5 SUBMITTALS

- A. Product Data:
  1. Product data to include, but not be limited to materials, finishes, testing agency approvals, load ratings, and dimensional information.
  2. Provide installation instructions for each type of hanger and support.
  3. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- B. Shop Drawings: Provide for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly. Indicate all loads exceeding 250 lbs imposed on building support systems and on structures.

- C. Informational Submittals:
  - 1. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
  - 2. Product certificates signed by manufacturer certifying that their product meet the specified requirements.

## 1.6 QUALITY ASSURANCE

- A. Welding:
  - 1. Qualify welding processes and welding operators according to the following codes depending on the material welded.
    - a. AWS D1.1 "Structural Welding Code--Steel."
    - b. AWS D1.2 "Structural Welding Code-Aluminum."
    - c. AWS D1.6 "Structural Welding Code-Stainless Steel."
  - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.
- D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
  - 1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of the General Conditions and manufacturer's recommendations.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS

- A. General:
  - 1. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated in catalogs.
  - 2. Special supports and hangers details will be required for cases where standard catalog supports are inapplicable.
  - 3. Materials: Unless otherwise shown on the Drawings, fabricate supports using the following materials:
    - a. Wetted and Submerged: Type 316 Stainless Steel.
    - b. Atmospheric Exposed: Hot-dipped galvanize after fabrication, coat in

accordance with SECTION 09 91 00 – PAINTING AND PROTECTIVE COATINGS.

c. Hardware: Type 316 Stainless Steel.

B. Hangers, Supports, and Components:

1. Selection and application of pipe hangers and supports for all service temperatures shall be in accordance with MSS SP-69.
2. Requirements for material, design and manufacture of standard types of hanger and support system components shall be in accordance with MSS SP-58.
3. Requirements for the fabrication and installation of the hanger and support system shall be in accordance with MSS SP-89.
4. Requirements relating to the design, selection, and applications of bracing for piping systems subject to seismic-wind-dynamic loading shall be in accordance with MSS SP-127.
5. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
6. Pipe attachments shall include a nonmetallic coating for electrolytic protection where attachments are in direct contact with copper pipe and tubing.

C. Products:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ANVIL International, Inc.
  - b. Cooper B-Line, Inc.
  - c. National Pipe Hanger Corporation
  - d. Piping Technology & Products, Inc.

## 2.2 HANGERS

- A. Adjustable Clevis Hanger: MSS SP-58, Type 1.
- B. Adjustable Swivel Ring for Non-Insulated Pipe: MSS Type 7.
- C. Hinged Split-Ring Pipe Clamp: MSS SP-58, Type 6 or 12.
- D. Yoke and Roller Hanger: MSS Type 41 and 43.
- E. U-Bolts: MSS Type 24.
- F. Straps: Mss Type 26.
- G. Anchor Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP-58.
- H. Attachments:
  1. I-Beam Clamp: Concentric loading type, MSS SP-58, Type 21, 28, 29, or 30, which engage both sides of flange.
  2. Concrete Insert: MSS SP-58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

## 2.3 PIPE SUPPORTS

- A. Pedestal Type: Galvanized Schedule 40 pipe stanchion, saddle, and anchoring flange.
  1. Adjustable Saddle: Anvil Figure 265 with galvanized adjustable U-Bolt.

- B. Pipe Stanchion: Anvil Figure 62 and 63 for support of steel pipe elbows, horizontal pipe, and for use with pipe saddles.

## 2.4 ROLLERS AND ROLLER SUPPORTS

- A. Roller with Adjustable Support Stand:
  - 1. Designed for pipe support where longitudinal movement and vertical adjustment is required.
  - 2. Non-metallic roller with stainless steel stand and hardware.
  - 3. Complies with MSS SP-69 and SP-58, Type 46.
- B. Roller with Non-Adjustable Support Stand:
  - 1. Designed for supporting pipe with longitudinal movement.
  - 2. Non-metallic roller with stainless steel chair, stand and hardware.
  - 3. Complies with MSS SP-69 and SP-58, Type 44.
- C. Roller with Ceiling Suspended Supports:
  - 1. Designed for suspending pipe where longitudinal movement and vertical adjustment is required.
  - 2. Steel with cast iron roller, standard finish.
  - 3. Complies with MSS SP-69 and SP-58, Type 43 or Type 41.

## 2.5 WALL SUPPORTS

- A. Horizontal Pipe:
  - 1. 1/4-Inch Thru 4 Inches: Offset or straight J-hook.
  - 2. 4 Inches and Greater: Welded steel bracket MSS Type 31, 32, or 33 and wrought steel clamp. Provide adjustable steel yoke and cast-iron roll MSS Type 44 for hot pipe 2000 F and over and for sizes 6 inches and greater.
- B. One-Hole Clamp: Anvil; Figure 126.
- C. Channel Type: Unistrut, Anvil, Cooper B-Line.

## 2.6 PIPE CLAMPS

- A. Riser Clamp: MSS SP-58, Type 4.
- B. Flexibility in hanger assembly required due to horizontal movement, use pipe clamps with weldless eye nuts: MSS SP-58, Type 4, with Type 17. For insulated lines use double bolted pipe clamps: MSS SP-58, Type 3, with Type 17.
- C. Offset Pipe Clamp: Galvanized carbon steel clamp for use is supporting piping away from floor or wall; Anvil Figure 103 or equivalent.
- D. Extension Pipe or Riser Clamp: Galvanized carbon steel riser clamp for support of vertical piping complying with MSS SP-69 and MSS-58, Type 8 and Type 42. Type 42 is designed also to be supported by hanger rods.

## 2.7 MULTIPLE OR TRAPEZE HANGERS

- A. Trapeze hangers constructed from 12-gauge roll formed ASTM A1011 SS Gr. 33 structural steel channel, 1-5/8-inch x 1-5/8-inch minimum.

- B. Mount pipes to trapeze with two-piece pipe straps sized for outside diameter of pipe.
- C. Pipes subject to axial movement:
  - 1. Use strut mounted roller supports; use pipe protection shield or saddles on FRP and insulated lines.
  - 2. Use strut mounted pipe guide as required.

## 2.8 CHANNEL TYPE SUPPORT SYSTEMS

- A. Steel Construction:
  - 1. Channel: Pre-galvanized in accordance with ASTM A525, Class G90, or hot-dip after fabrication.
  - 2. Hardware: Type 316 stainless steel.
  - 3. Channel Size:
    - a. Single Channel: 14-gauge, 1-5/8" by 1-5/8".
    - b. Double Channel: 14-gauge, 3-1/4" by 1-5/8".
    - c. Manufacturer: Unistrut Series P1000 or equivalent.
  - 4. Members and Connections: MFMA-2, factory-fabricated components for field assembly. Design for all loads with Safety Factor of 5.
  - 5. Pipe and Tubing Clamps: Unistrut "Cush-A-Clamp" Omega Series or U-Bolt Series, stainless steel construction with thermoplastic elastomer cushion or equivalent.
- B. Fiberglass Construction:
  - 1. Channel: Polyester and vinylester reinforce with multiple strands of glass filament, UV resistant surfacing veils channels.
    - a. Single Channel: Heavy duty 1-5/8" by 1-5/8"; Unistrut Series F20V-2000.
    - b. Double Channel: Heavy duty 3-1/4" by 1-5/8"; Unistrut Series F20V-2100.
  - 2. Seal all cut ends with a clear sealer and provide end caps on exposed ends after assembly.
  - 3. Hardware: Fiberglass or stainless steel.
- C. Available Manufactures:
  - 1. Anvil; Power-Strut Line
  - 2. Cooper B-Line
  - 3. National Pipe Hangers Corporation
  - 4. Unistrut Corporation

## 2.9 ACCESSORIES

- A. Protection Shields: MSS Type 40; galvanized steel or stainless steel, 180 degrees arc, minimum 12 inches long, to prevent crushing insulation.
- B. Protection Saddles: MSS Type 39; fill interior with segments of insulation matching adjoining insulation.
- C. Thermal Shields:
  - 1. Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe, with length

recommended by the manufacturer for pipe size and thickness of insulation.

2. Cold Piping: Calcium silicate shall extend beyond the sheet metal shield allowing overlap of vapor barrier.
3. Piping, 4 inches and larger, supported on trapeze or pipe rollers, provide double thickness shields.
4. Piping, 12 inches and greater, provide 600 psi calcium silicate structural insert.

D. Vibration Isolation and Supports:

1. For refrigeration, air conditionings, hydraulic, pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening inserts and a nylon inserted locknut. For copper and steel tubing use Cooper B-Line BVT series VibraClamps, for pipe sizes use BVP series, or equivalent.
2. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required. For spring hangers use Mason or equal.
3. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
4. Vibration isolation products as manufactured by Cooper B-Line, VibraTrol systems, or equivalent.

E. Intermediate Pipe Guides:

1. Piping, 6 inches and smaller:
  - a. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.
2. Piping, 8 inches and larger:
  - a. Type: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe.
  - b. U-Bolt Stock Size:
    - 1) 8-inch Pipe: 5/8-inch
    - 2) 10-inch Pipe: 3/4-inch
    - 3) 12-inch through 16-inch Pipe: 7/8-inch
    - 4) 18-inch through 30-inch Pipe: 1-inch

F. Pipe Alignment Guides:

1. Piping 8 inches and Smaller: Spider or sleeve type.
2. Piping 10 inches and Larger: Roller type.

G. Pipe Anchors:

1. Type: Anchor chair with U-bolt.

H. Hangers shall be threaded at either end or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

## 2.10 MISCELLANEOUS MATERIALS

- A. Hanger Support Anchors: Comply with the requirements of SECTION 05 05 23 - ANCHOR BOLTS, EXPANSION ANCHORS, AND INSERTS for cast-in-place anchors, concrete and masonry drilled anchors, and material of construction for anchors based on the

environment.

1. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- B. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by Engineer.
  1. Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
- E. Washers: ASTM F 844, steel, plain, flat washers.
- F. Grout: ASTM C 1107, Grade B, non-shrink and non-metallic;
  1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
  2. Design Mix: 5000-psi, 28-day compressive strength.
  3. Water: Potable.
  4. Packaging: Premixed and factory-packaged.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Examine areas and conditions under which the hanger and support system will be installed. Do not proceed with work until satisfactorily conditions have been corrected in manner acceptable to installer.
- B. Proceed with installation of the hanger and support system only after required structural work has been completed in areas where work is to be installed. Correct inadequacies including, but not limited to. Proper placement of inserts, anchors, and other structural attachments. Review Drawings to obtain structural support limitations.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support Installation: Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
  1. Field assemble and install according to manufacturer's instructions.
- C. Heavy-Duty Steel Trapezes: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricate heavy-duty trapezes.
  1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install support intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field-fabricate from ASTM A36 steel shapes selected for loads being supported.



3. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
  - E. Install powder-actuated drive-pin fasteners 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. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.
  - F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.
  - G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
  - H. Support fire protection systems piping independent of other piping.
  - I. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
  - J. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
  - K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded. Insulated Piping: Comply with the following installation requirements.
    1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
    2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
    3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

<b>Table 3</b>		
<b>Shield Length and Thickness</b>		
<b>NPS (Inches)</b>	<b>Shield Length (Inches)</b>	<b>Shield Thickness (Inches)</b>
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 8 Inches (200 mm) and Larger: Include wood inserts.

5. Insert Material: Length at least as long as the protective shield.
  6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.
- L. Piping Support General Applications:
1. Support piping connections to equipment by pipe support and not by the equipment.
  2. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
  3. Do not support one pipe from another.
  4. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
  5. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
  6. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
  7. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
  8. Repair mounting surfaces to original condition after attachments are made.
- M. Standard Pipe Supports:
1. Horizontal Suspended Piping:
    - a. Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.
    - b. Grouped Pipes: Trapeze hanger systems.
    - c. Furnish galvanized steel protection shield and oversized hangers for all insulated pipes.
    - d. Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.
  2. Horizontal Piping Supported from Walls:
    - a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
    - b. Stacked Piping:
      - 1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch nominal diameter.
      - 2) Piping clamps which resist axial movement of pipe through support not acceptable.
    - c. Wall mounted piping clips not acceptable for insulated piping.
  3. Horizontal Piping Supported From Floors:
    - a. Stanchion Type:
      - 1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
      - 2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.
      - 3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
    - b. Floor Mounted Channel Supports:
      - 1) Use for piping smaller than 3-inch nominal diameter running along floors

and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

- 2) Attach channel framing to floors with anchor bolts.
  - 3) Attach pipe to channel framing with clips or pipe clamps.
  - c. Concrete Cradles: Use for piping larger than 3-inch nominal diameter along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
  4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
  5. Standard Attachments:
    - a. To Concrete Ceilings: Concrete inserts.
    - b. To Steel beams: I-beam clamps or welded attachments.
    - c. To Wooden Beams: Lag screws and angle clips to members with anchor bolts.
    - d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
  6. Existing Walls and Ceilings: Install as specified unless otherwise shown.
- N. Intermediate and Pipe Alignment Guides:
1. Provide pipe alignment guides (or pipe supports that accomplishes the same function) at all expansion joints and loops.
  2. Guide piping on each side of an expansion joint or loop at four to fourteen pipe diameters distance from each joint or loop.
  3. Install intermediate guides on metal framing support systems not carrying a pipe anchor or alignment guide.
- O. Accessories:
1. Insulation Shield: Install on insulated non-steel piping. Oversized rollers and supports.
  2. Welding Insulated Saddle: Install on insulated steel pipe. Oversized rollers and supports.
  3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
  4. Dielectric Barrier:
    - a. Install between carbon steel members and copper or stainless steel pipe.
    - b. Install between stainless steel supports and nonstainless steel ferrous metal piping.
  5. Electrical isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.
- P. Piping and ductwork supports are to be independent supports and directly supported from building or structure. Combining supports from more than one trade is not permitted.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make a smooth bearing surface.

### 3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe 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 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in SECTION 09 90 00 - PAINTING AND PROTECTIVE COATINGS.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

### 3.7 VIBRATION

- A. Vibration of the piping system during operation is not acceptable.
- B. Contractor shall provide additional lateral supports as required to eliminate piping vibration at no addition cost to Owner.

**END OF SECTION**

**SECTION 33 05 31.23**  
**PIPING SYSTEM, FUSIBLE PVC PIPE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Fusible polyvinyl chloride piping systems, 4-inch through 36-inches, for potable water and non-potable water.
- B. Related Work:
  - 1. This Section contains material requirements for pipe, fittings, specials, and appurtenances for fusible polyvinyl chloride piping systems.

**1.3 REFERENCES**

- A. References: Following is a list of standards, which might be referenced in this Section:
  - 1. American National Standards Institute (ANSI):
    - a. A21.10 – Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
    - b. A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
    - c. A21.53 - Standard for Ductile-Iron Compact Fittings for Water Service
  - 2. American Water Works Association (AWWA):
    - a. C605 – Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
    - b. C651 - Standard for Disinfecting Water Mains
    - c. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100mm through 1200mm), for Water Distribution
    - d. M23 - AWWA Manual of Supply Practices PVC Pipe—Design and Installation
    - e. M28 – AWWA Manual-Rehabilitation of Water Mains
  - 3. ASTM International, Inc. (ASTM):
    - a. A193 – Specification for Alloy-Steel and Stainless-Steel bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
    - b. A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
    - c. A307 – A307 – Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength
    - d. A563 – A563 – Specification for Carbon and Alloy Steel Nuts
    - e. C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
    - f. D1784 – Specification Rigid Poly (Vinyl Chloride) (PVC) Compounds and

Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

- g. D1785 – Specification Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- h. D2241 – Specification Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
- i. D2665 – Specification Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- j. F477 –Specification Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- k. F1417 – Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
- 4. National Science Foundation (NSF):
  - a. NSF 14 – Plastics Piping System Components and Related Materials
  - b. NSF 61 - Drinking Water System Components--Health Effects
- 5. UNI-BELL Pipe Manufacturers Association (UNI-BELL):
  - a. PUB 6 - Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
  - b. PUB 8 - Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 Inch)
- 6. Plastics Pipe Institute (PPI): TR-2 PVC Range Composition Listing of Qualified Ingredients

1.4 QUALITY ASSURANCE

- A. Manufacturer: Fusible polyvinylchloride pipe shall be tested at the extrusion facility for properties required to meet all applicable parameters as outlined in AWWA C900 and applicable sections of ASTM D2241. Testing priority shall be in conformance with AWWA C900.
- B. Installer: Fusion Technician shall be fully qualified by the pipe supplier to install fusible polyvinylchloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.

1.5 SUBMITTALS

- A. The following product data shall be provided by the Contractor prior to fabrication of the pipe.
  - 1. Pipe Size
  - 2. Dimensionality
  - 3. Pressure Class per applicable standard
  - 4. Color
  - 5. Recommended Minimum Bending Radius
  - 6. Recommended Maximum Safe Pull Force
  - 7. Fusion Technician qualification indicating conformance with this specification.
- B. The following As-Recorded Data shall be furnished by the Contractor after the installation of the pipe.
  - 1. Approved datalogger device reports

2. Fusion joint documentation containing the following information:
  - a. Pipe Size and Thickness
  - b. Machine Size
  - c. Fusion Technician Identification
  - d. Job Identification
  - e. Fusion Joint Number
  - f. Fusion, Heating and Drag Pressure settings
  - g. Heat Plate Temperature
  - h. Time Stamp
  - i. Heating and Cool Down Time of Fusion
  - j. Ambient Temperature

#### 1.6 WARRANTY

- A. The pipe shall be warranted for one year per the pipe supplier's standard terms.
- B. In addition to the standard pipe warranty, the fusion services shall be warranted for one year per the fusion service provider's standard terms.

### PART 2 - PRODUCTS

#### 2.1 FUSIBLE POLYVINYL CHLORIDE PIPE

- A. Fusible polyvinylchloride plastic material for pipe shall conform to AWWA C900, ASTM D1785, and cell classification 12454. Pipe shall be in accordance with ASTM D2241 for IPS standard dimensions as indicated in these specifications.
  1. Pipe shall be manufactured with 100% virgin resin.
  2. Pressure Pipe: Compound formulation shall be in accordance with PPI TR-2/2006.
  3. Manufactured in standard 40' nominal lengths, or custom lengths as specified.
- B. Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- C. Pipe Color:
  1. Potable Water Service: Blue
  2. Non-Potable Water Service: Purple
  3. Wastewater Service: Green
- D. Pipe shall be marked per AWWA C900 and shall include as a minimum:
  1. Nominal size
  2. PVC
  3. Dimension Ratio, Standard Dimension Ratio or Schedule
  4. AWWA pressure class or rating
  5. AWWA Standard designation number
  6. NSF-61 mark verifying suitability for potable water service
  7. Extrusion production-record code
  8. Trademark or trade name

9. Cell Classification 12454 and/or PVC material code 1120 may also be included.
- E. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
- F. NSF Certified: All surfaces and materials in contact with water, or in contact with a chemical being applied to water that is being treated for potable water use and conveyance, shall conform to NSF-14 and NSF-61 and certified by an organization accredited by ANSI.

## 2.2 FUSION JOINTS

- A. Unless otherwise specified, fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written instructions for this procedure. Joint strength shall be equal to the pipe as demonstrated by testing requirements. All fusion joints shall be completed as described in this specification.

## 2.3 CONNECTIONS AND FITTINGS, PRESSURE PIPE APPLICATIONS

- A. Ductile Iron Mechanical Fittings: Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard ductile iron fittings conforming to ANSI A21.10 and ANSI A21.11.
- B. Restrained connections to fusible polyvinylchloride pipe may be made using a restrained retainer gland product for DIPS or IPS sizing, as well as for MJ or flanged fittings.
  1. Available Manufacturers:
    - a. EBAA Iron – Megalug Series 2000PV, 2000SV, 2100, or Series 2200
    - b. Smith-Blair – Cam-Lok, 111/120 series
  2. Bends, tees and other ductile iron fittings shall be restrained with the use of mechanical restraints as indicated on the drawings.
  3. Ductile iron fittings and retainer glands must be installed per the manufacturer's recommendations.
- C. PVC Gasketed, Push-On fittings:
  1. Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard PVC pressure fittings conforming to AWWA C900.
  2. Acceptable fittings for use joining fusible polyvinylchloride pipe to other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings as shown in the drawings.
  3. Bends, tees and other PVC fittings shall be restrained with the use of mechanical restraints.
  4. PVC gasketed, push-on fittings and mechanical restraints, if used, must be installed per the manufacturer's recommendations.
- D. Sleeve-Type Couplings:
  1. Available Manufacturers:
    - a. Mechanical couplings for restrained:
      - 1) EBAA Iron Series 3800
  2. Sleeve-type mechanical couplings shall be manufactured for use with PVC pipe, and shall be restrained as indicated on the drawings and in these specifications.

## 2.4 TRACER WIRE



- A. Buried piping shall be installed with a continuous, insulated TW, THW, THWN, or HMWPE insulated copper, 10 gauge or thicker wire for pipeline location purposes by means of an electronic line tracer.
  - 1. Installed wires along the entire length of the pipe.
  - 2. Insulation color shall match the color of pipe being installed.
  - 3. Sections of wire shall be spliced together using approved splice caps and waterproof seals. Twisting the wires together is not acceptable.

### PART 3 - EXECUTION

#### 3.1 DELIVERY AND OFF-LOADING

- A. All pipes shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Owner or Engineer.
- B. Each pipe shipment shall be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify Owner or Engineer immediately if damage is found. Each pipe shipment shall be checked for quantity, proper size, color and type.
- C. Pipe should be loaded, off-loaded and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's guidelines shall be followed.
- D. Off-loading devices such as chains, wire rope, chockers, or other pipe handling implementations that may scratch, nick, cut, or gouge the pipe are strictly prohibited.

#### 3.2 HANDLING AND STORAGE

- A. Any length of pipe showing a crack, or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits or acceptable length of pipe shall be determined by the Owner or the Engineer.
- B. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Owner or Engineer.
- C. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
- D. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.
- E. Pipe shall be stored and stacked per the pipe manufacturer's guidelines.

#### 3.3 FUSION PROCESS

- A. General Requirements:
  - 1. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's recommendations.
  - 2. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians, as

documented by the pipe supplier. Training records for qualified fusion technicians shall be available to Owner or Engineer upon request.

3. Each joint fusion shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint data shall be submitted as part of the As-Recorded information, in accordance with this specification.
  4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following properties, including the following elements:
    - a. Heat Plate: Heat plates shall be in good condition with no deep gouges or scratches within the pipe circle being fused. Plates shall be clean and free of any contamination. Heater controls shall properly function, and cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's recommendations.
    - b. Carriage: Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
    - c. Data Logger: Pipe supplier's recommended and compatible software shall be used. Protective case shall be utilized for the hand-held wireless portion of the unit. Data logger operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
  5. Other equipment specifically required for the fusion process shall include the following:
    - a. Pipe rollers shall be used for support of pipe to either side of the machine
    - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement and /or windy weather.
    - c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
    - d. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
    - e. Facing blades specifically designed for cutting fusible polyvinyl chloride pipe.
- B. Joint Recording: Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of thermoplastic pipe. The software shall register and/or record the parameters required by the manufacturer and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

### 3.4 INSTALLATION

#### A. Fusion and Layout:

1. All fusion of the pipe shall occur at surface level. No fusion will be completed in the excavated area or trench.
2. Pipe lengths shall be fused in their entirety and staged prior to installation in the trench. Fused pipe lengths shall be determined by Contractor preference, manufacturer's recommendations and site constraints.

- B. Trenching, Backfilling and Compacting shall be completed in accordance with Division 31 Section 31 23 33 "Trenching, Backfilling and compacting".
- C. Pipe Installation:
1. Fused lengths of pipe shall be installed by lowering into the trench or excavation, using approved strapping per these specifications. The lowering operation once initiated shall proceed until the entire length of the fused section of pipe is installed.
  2. Coordination of lifting equipment shall ensure that the fused pipe does not exceed the bending and buckling limitations of the pipe, per the manufacturer's recommendations.
    - a. Three pick points shall be utilized at all times and shall be staged per the manufacturer's recommendations.
    - b. Under no circumstances will the pipe be "dropped" or "rolled" into the trench or excavation.
  3. If the length of the fused pipe is longer than what the available equipment can lower into the trench or excavation at one time, equipment shall be staged so that lowering shall begin at one end of the installation, and proceed along the trench or excavation, so that the entire fused length is installed without exceeding the bending limitations of the fused pipe.
  4. Pipe may also be installed by dragging it into the end of the trench via a sloped section that is constructed so as not to exceed the bending radius of the pipe. Pipe may be pulled by the use of a pull head and winch or piece of construction machinery as recommended by the pipe supplier.
  5. Fused pipe shall be bedded and backfilled per the drawings, these specifications and all applicable jurisdictional standards. Lengths of fused polyvinylchloride pipe shall be bedded and removed from direct sunlight for a period of at least two minutes per inch-diameter before any connections are made. This period of thermal equalization of the pipe is to assure proper connections may be installed.
  6. The fusible polyvinylchloride pipe shall be handled with care to minimize the possibility of it being cut, kinked, gouged, or otherwise damaged. The use of cables or hooks will not be permitted.
  7. Sections of the fusible polyvinylchloride pipe damaged, cut, or gouged shall be repaired by cutting out the section of damaged pipe and then rejoining.
  8. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius.
  9. Where fusible polyvinylchloride pipe is installed by pulling in tension, the recommended Safe Pulling Force, according to the pipe supplier, will not be exceeded.

### 3.5 PREPARATION PRIOR TO MAKING CONNECTIONS INTO EXISTING PIPING SYSTEMS

- A. Approximate locations for existing piping systems are shown on the drawings or detailed in the specifications. Prior to making connections into existing piping systems, the Contractor shall:
1. Field verify location, size, piping material and piping system of the existing pipe.
  2. Obtain all required existing piping manufacturer(s) approved fittings (i.e., saddles, sleeve type couplings, flanges, tees, etc., as shown).

3. Have installed all temporary pumps and/or pipes in accordance with established connection plans.
  4. Have on hand necessary pipe stoppers, pancake flanges or other items which may be necessary should an existing valve or appurtenance fail to seal properly.
- B. Unless otherwise approved by the Engineer, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.

### 3.6 FIELD QUALITY CONTROL

- A. Testing of the piping system shall be completed in accordance with Division 01 Section 01 45 00 "Quality Control".
- B. Tracer Wire Testing: Upon completion of the directional bore, the Contractor shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.
1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of Engineer.
  2. If the wire is broken, the Contractor shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

### 3.7 TAPPING FOR PORTABLE AND NON-PORTABLE WATER APPLICATIONS

- A. Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. NO DIRECT TAPPING WILL BE PERMITTED. Tapping shall be performed in accordance with the applicable sections for Saddle Tapping per Uni-Pub-8.
- B. Tapping sizes shall be limited to the following maximum tapping diameters and methods for the nominal pipe diameters as indicated in the table below:

Nominal Pipe Size (in.)	Nominal Tap Size (in.)								
	¾	1	1 ½	2	4	6	8	10	12
4	NTP	RH	RH	RH	X				
6	NTP	NTP	RH	RH	X	X			
8	NTP	NTP	RH	RH	RTS	X	X		
10	NTP	NTP	RH	RH	RTS	X	X	X	
12	NTP	NTP	RH	RH	RTS	RTS	X	X	X
14	NTP	NTP	RH	RH	RTS	RTS	X	X	X
16	NTP	NTP	NTP	NTP	RTS	RTS	RTS	X	X
18	NTP	NTP	NTP	NTP	RTS	RTS	RTS	X	X
20	NTP	NTP	NTP	NTP	RTS	RTS	RTS	RTS	X
24	NTP	NTP	NTP	NTP	RTS	RTS	RTS	RTS	RTS
30	NTP	NTP	NTP	NTP	NTP	NTP	RTS	RTS	RTS
36	NTP	NTP	NTP	NTP	NTP	NTP	RTS	RTS	RTS
<b>NTP</b>	Normal Tapping Procedures								
<b>RH</b>	Restraining Harness								
<b>RTS</b>	Restrained Tapping Sleeve								
<b>X</b>	Tapping is Not Allowed								

- C. All other connections requiring a larger diameter shall be made with a pipe connection as specified and indicated on the drawings.
- D. Equipment used for tapping shall be made specifically for tapping PVC pipe:
  - 1. Tapping bits shall be slotted “shell” style cutters, specifically made for PVC pipe. ‘Hole saws’ made for cutting wood, steel, ductile iron, or other materials are strictly prohibited.
  - 2. Manually operated or power operated drilling machines may be used.
- E. Taps may be performed while the pipeline is filled with water and under pressure (‘wet’ tap), or when the pipeline is not filled with water and not under pressure (‘dry’ tap).

**END OF SECTION**

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**SECTION 33 11 13.13**  
**PIPING SYSTEM, DUCTILE IRON PIPE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section provides requirements for ductile iron piping system for exposed and buried applications and includes:
1. Mechanical joint, push-on and flanged ductile iron pipe, sizes 4-inch through 30 inch.
  2. Mechanical joint and flanged ductile iron fittings, sizes 4-inch through 30-inch.
  3. Gaskets and fasteners.
  4. Protective coatings, linings and encasements.
- B. Related Sections:
1. Refer to Division 00 and Division 33 for information regarding submittals; coordination; material delivery, handling, and storage; projection conditions; design requirements; other materials; installation of piping systems; field testing; and related work.
  2. This Section contains material requirements for pipe, fittings, specials, and appurtenances for the ductile iron piping systems, as well as Part 1 – General and Part 3 – Execution additional requirements not specified in the above referenced Section.

**1.3 REFERENCES**

- A. American Water Works Association (AWWA):
1. C104/A21.4 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  2. C105/21.5 – Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids.
  3. C110-C21.10 – American National Standard for Gray-Iron and Ductile-Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
  4. C111/A21.11 – American National Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
  5. C115/A21.15 – American National Standard for Flanged Cast-Iron and Ductile-Iron Pipe with Threaded Flanges.
  6. C150/A21.50 – American National Standard for the Thickness Design of Ductile Iron Pipe.
  7. C151/A21.51 – American National Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids.
  8. C153/A21.10 – Ductile-Iron Compact Fittings for Water Service.
  9. C600 – Installation of Ductile Iron Water Mains and Their Appurtenances.
  10. C606 – Grooved and Shouldered Joints.
  11. M41 – Manual Ductile Iron Pipe and Fittings.

- B. ASTM International, Inc. (ASTM):
  - 1. A48 – Specification for Gray Iron Castings.
  - 2. A193 – Specification for Alloy-Steel and Stainless Steel bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
  - 3. A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, of Both.
  - 4. A307 – Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength.
  - 5. A320 – Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low Temperature Service.
  - 6. A536 – Specification for Ductile Iron Castings.
  - 7. A563 – Specification for Carbon and Alloy Steel Nuts.
  - 8. A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or other Liquids.
  - 9. D1330 – Specification for Rubber Sheet Gaskets.
- C. National Sanitation Foundation (NSF):
  - 1. NSF/ANSI 61 – Drinking Water Components – Health Effects.
- D. International Organization for Standardization (ISO):
  - 1. ISO 8179 – Ductile Iron Pipes, Fittings, Accessories and their Joints – External Zinc-Based Coating

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  - 1. Prior to the fabrication of the pipe and laying shop drawings, the Contractor shall submit fabrication and lay drawings to the Engineer as shop drawings showing the northing, easting, and top of pipe elevation at each joint location where the proposed pipe connects to existing pipes.
  - 2. Prior to the fabrication of the pipe, submit fabrication and lay drawings to the Engineer as Shop Drawings. Shop drawings shall include a complete description of the pipe offered, including cuts, tabulated layout and pertinent design data. Shop drawings shall reference stationing on the plan/profile sheets and shall incorporate changes necessary to avoid conflicts with existing utilities and structures and adjustments necessary to make tie-ins. Details for the design and fabrication of all fittings and specials and provisions for thrust shall be included. Manufacturer and Contractor shall field verify pipe tie-in connections for adequate thrust restraint.
  - 3. In addition to lay drawings as required above, provide modified vertical profile as needed to incorporate standard fitting angles required in the plans. This includes at minimum a markup of the plan and profile drawings with revised pipe elevations, fitting locations (stations) and angles. Pipe shall maintain a minimum cover of 5 feet and not introduce any new high points in the profile.
  - 4. Schedule of materials furnished.
- C. Material Certificates:
  - 1. Certificate of Compliance with all applicable and appropriate reference standards certifying that all pipe, fittings, and specials, and other products and materials



furnished, comply with the applicable provision of the Specification.

2. Certification of Adequacy of Design: The Certificate of Adequacy of Design shall show the necessary provisions required in the design of the pipe to comply with applicable sections of this Specification. A Professional Engineer registered in the state where the Project is located shall seal the Certificate of Adequacy of Design.
- D. Hydraulic Thrust Restraint – Provide calculations detailing the restraint required for all pipe assemblies, fittings, valves, and plugs. Calculations shall detail the restrained joint length required at all necessary points on the piping schedule. Separate details including materials, size, assembly ratings and pipe attachment methods shall be provided. Thrust restraint requirements shall be prepared and sealed by a Professional Engineer licensed in the State of Oklahoma.
  - E. Field quality-control test reports.
  - F. Prior to final completion, submit as-built, top-of-pipe survey as Record Data. Top-of-pipe survey shall include station and top-of-pipe elevation for each pipe joint. Survey information shall be provided on the Contractor’s “As-Built” drawings.

## 1.5 PROJECT REQUIREMENTS

- A. Restrained Pipe and Fitting Joints, Buried Piping:
  1. Restrained joints shall be used for a sufficient distance from each bend, tee, elbow, plug, or other fitting to resist thrust that will develop at the design pressure.
  2. CONTRACTOR shall provide restraint length calculations in accordance with AWWA M41 based on the laying conditions, soil conditions, depth of cover, and pressures as follows to determine the number of restrained joints that will be required.
    - a. Design Pressure: 150 psi
    - b. Suggested soil parameters, unless otherwise specified: Coh-gran as indicated in Table 8-2 of the latest edition of M41.
    - c. Unit Weight of Soil: 60 pcf (maximum value used)
    - d. Height of cover: as shown in plans
    - e. Safety factor: 1.5
  3. For the purposes of thrust restraint, design pressures shall be the working pressure shown, plus the additional surge allowance for potable water, service water, and pump discharge piping. The design pressure for joint restraint shall be 1.5 times the pressure class.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. General: Ductile iron with a thickness design for the pressures and laying conditions complying with the requirements of AWWA C150 and the manufactured in accordance with AWWA C151.
  1. Comply with the following minimum thickness class, unless otherwise indicated in the Pipe Schedule.
    - a. Pressure Class 250, pipe up to 8-inches.
    - b. Pressure Class 200, pipe 8-inch and larger.
- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain

spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  2. Gaskets: AWWA C111, rubber.
- D. Flanged-Joint, Ductile-Iron Pipe: AWWA C151, flanged ends.
1. Flange Joints: Comply with the requirements of AWWA C115.
    - a. Class 250 as designated on Drawings or Pipe Schedule.
  2. Bolting:
    - a. ASTM A193 or ASTM A320, Type 304 stainless steel bolts; ASTM A194, Type 316, nuts; and washers of the same material as the bolts. Nuts shall be PTFE coated.
    - b. Gaskets:
      - 1) Flange, Flat Face: Full-faced, AWWA C111, 1/8-inch thick rubber, factory cut.
  3. All ductile iron piping associated with the lift station and valve vault shall have flanged ends.

## 2.2 SPECIAL PIPE FITTINGS

- A. Flange adapter: For joining steel pipe to cast iron, provide Dresser Style 127 or equal. Gasket to be Buna-S, Grade 27.
- B. Reducing and Transition Coupling: Required for making reduction in sizes of piping; changing classes of piping; or joining steel and cast iron pipe, provide Dresser Style 62 or equal.

## 2.3 PROTECTIVE COATINGS, LININGS, AND ENCASEMENT

- A. Pipe and Fittings Interior:
  1. Mortar: Unless otherwise specified in the Piping Schedule, all ductile iron pipe and fittings shall be provided with a cement-mortar lining in accordance with AWWA C104.
- B. Pipe and Fittings Exterior:
  1. Pipe and fittings associated with the lift station and valve vault shall receive an epoxy coating in accordance with Division 09 Section 09 91 00 for ferrous metals submerged or intermittently submerged in non-potable water.
  2. For all other ductile iron pipe, provide exterior coating of arc-sprayed zinc per ISO 8179. The mass of the zinc applied shall be 200 g/m<sup>2</sup> of pipe surface area.
  3. Finishing Layer (Topcoat): A finishing layer of asphalt paint or synthetic resin topcoat compatible with zinc shall be applied. The mean dry film thickness of the finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils.
  4. Any necessary repairs to the zinc coating shall be made in accordance with ISO 8179.

- C. Encasement for Underground Metal Piping: ASTM A674 or AWWA C105.
  - 1. Form: Tube.
  - 2. Material: V-Bio Enhanced Polyethylene Encasement.
  - 3. Polyethylene encasement shall consist of three layers of coextruded linear low-density polyethylene fused into a single thickness of not less than 8 mils.
  - 4. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
- D. Color: Black.

## 2.4 INSULATED CONNECTIONS

- A. Provide dielectric insulation kits, including gaskets, insulating sleeves and washers for each bolt and nut, where flanges are to be cathodically insulated. Refer to the Contract Documents for the individual locations. Metal hardware such as backup washers shall be Type 304 stainless steel. Refer to Division 40 Section 40 46 00 "Corrosion Monitoring" for additional information.

## 2.5 ADDITIONAL SPARE PARTS

- A. At completion of construction, contractor shall provide the following spare parts to the OWNER.
  - 1. 2 solid sleeves
  - 2. Full circle clamp

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with the requirements of Division 40 Section 40 05 00. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Laying Buried Pipe:
  - 1. Install pipe to the lines, grades and elevations shown on the Drawings, complying with the requirements of AWWA C600.
  - 2. Unless otherwise shown on the Drawings, bury lines 12 inches and smaller with a minimum cover of 4-feet and lines 14 inches and larger with a minimum cover of 5-feet.
  - 3. Do not lay pipe in water, or when the trench or weather is unsuitable for work. Keep water out of trench until jointing is complete. When work is not in progress, close ends of pipe and fittings securely so no trench water, earth or other substances will enter pipes or fittings.
  - 4. Keep the inside of the pipe free from foreign matter during operations by plugging or other approved method.
  - 5. Provide pipe bedding in accordance with the Drawings and Section 31 23 33 "Trenching, Backfill, and Compacting". Place pipe so that the full length of each section rests solidly upon the pipe bed, with recesses excavated to accommodate bells and joints. Take up and relay pipe when the grade or joint is disturbed after laying.
  - 6. Lay pipe with bells facing the direction of the laying except when making enclosures.

7. Buried pipe and fittings shall be V-Bio Enhanced Polyethylene Encasement wrapped in accordance with AWWA C105 Installation Method A or Ductile Iron Pipe Research Association Modified Installation Method A.

C. Restrained Joints:

1. Thrust blocks will not be allowed as the primary method of restraint. The CONTRACTOR, at his option, may install thrust blocking in addition to individual joint restraint, but it shall not constitute a replacement for individual joint restraint.
2. Fittings:
  - a. Unless otherwise indicated on the drawings, the CONTRACTOR shall use mechanical restrained pipe joints or push on style at all buried fittings (no thrust blocks). The length of pipe requiring thrust restraint shall be calculated as described in Chapter 13 of AWWA M41.
  - b. All restrained joints shall have a working pressure equal to or greater than the pipe pressure class.
  - c. Mechanical joint restraint
  - d. Mechanical joints shall be mechanically restrained
    - 1) Available manufacturer:
      - a) Ebaa Iron Series 1100 MEGALUG
      - b) Approved equal
3. Pipe Joints:
  - a. Unless otherwise indicated on the drawings, the CONTRACTOR shall use restrained bell and spigot pipe to achieve the restrained joint length required for the pipe design. Push on style with boltless pipe joints. All restrained joints shall have a working pressure equal to or greater than the pipe pressure class.
4. Exposed pipe:
  - a. Unless otherwise indicated on the drawings, all exposed pipe shall be flanged.
5. CONTRACTOR shall design restrained joints based on the specified pressures as shown in the Piping Schedule or Drawings and in accordance with AWWA M41.
6. The design for restrained joints, including the length necessary to resist the design thrust, for the embedded conditions, shall be performed and sealed by a Professional Engineer in the state where the Project is being constructed.
7. CONTRACTOR shall bear all costs for the design and will not receive reimbursement from the OWNER.

### 3.2 HYDROSTATIC TESTING

- A. Installed pipeline shall be hydrostatically tested in accordance with Division 01 Section 01 45 00 "Quality Control".

### 3.3 FIELD QUALITY CONTROL

- A. All piping systems shall be thoroughly cleaned and flushed, and all construction debris or foreign material removed. The CONTRACTOR shall provide all temporary connections, equipment and the like for cleaning.

### 3.4 SITE CLEAN-UP

- A. All excavations shall be backfilled and compacted per the Contract Documents. All disturbed

areas shall be restored to preconstruction conditions or better and to the lines and grades shown in the Contract Documents. All disturbed areas shall be seeded or sodded per the Contract Documents. Any disturbed pavement will be repaved to as good or better condition per the Contract Documents.

### 3.5 PIPING SCHEDULE

- A. As shown on the Drawings.

**END OF SECTION**

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**SECTION 33 11 13.19**  
**PIPING SYSTEM, POLYVINYL CHLORIDE (PVC)**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section provides requirements for PVC piping systems for exposed and buried applications, pressure and gravity applications and includes:
1. Polyvinyl Chloride (PVC) pressure pipe and fittings in sizes 1/2-inch through 48-inch.
  2. PVC, Schedule 40 and 80, pressure pipe and fittings.
  3. PVC gravity sewer and drain pipe and fittings.
- B. Related Work:
1. Refer to Division 40 Section 40 05 00 "Piped Utilities: Basic Materials and Methods" for information regarding submittals; coordination; material delivery, handling, and storage; projection conditions; design requirements; other materials; installation of piping systems; and related work.
  2. This Section contains material requirements for pipe, fittings, specials, and appurtenances for PVC piping systems, as well as Part 1 – General and Part 3 – Execution additional requirements not specified in the above referenced Section.

**1.3 REFERENCES**

- A. References:
1. American Waterworks Association (AWWA):
    - a. C110 – Standard for Ductile-Iron and Gray-Iron Fittings, 3-In. Through 48-In. (76 mm Through 1,219 mm) for Water
    - b. C111 – American National Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
    - c. C153 – Ductile-Iron Compact Fittings for Water Service
    - d. C219 – Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
    - e. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-in. – 60-in. (100 mm-1,500 mm)
    - f. C907 – Standard for Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4-in. Through 12-in. (100 mm Through 300 mm)
    - g. F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
    - h. F1417 – Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
    - i. F1668 – Guide for Construction Procedures for Buried Plastic Pipe
    - j. F1674 – Test Method for Joint Restraint Products Used With PVC Pipe.
  2. ASTM International, Inc. (ASTM):
    - a. D1785 – Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedule 40, 80,

- and 120
- b. D2466 – Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40
- c. D2467 – Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80
- d. D2564 – Specifications for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- e. D3034 – Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and fittings
- f. F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- g. F679 – Specification for Poly(Vinyl Chloride)(PVC) Large-Diameter Gravity Sewer Pipe and Fittings
- h. F794 – Specification for Poly(Vinyl Chloride)(PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
- i. F891 - Specification for Coextruded Poly(Vinyl Chloride)(PVC) Plastic Pipe With a Cellular Core
- j. F493 – Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
- 3. National Science Foundation (NSF):
  - a. NSF/ANSI 61 – Drinking Water Systems Components – Health Effects

#### 1.4 SUBMITTALS

- A. Comply with Section 01 33 10 “Submittal Procedures.”
- B. Product Data: For each type of product indicated.
- C. Shop Drawings:
  - 1. Pipe layout drawings shall include plan, elevations, sections, details, and attachments to other work.
  - 2. Pipe layout schedule/drawings including pipeline stationing, elevation, and restrained joint locations.
  - 3. Schedule of materials furnished.
  - 4. Pipe layout drawings and data shall clearly indicate where pipe requiring special provisions are to be located, connections to equipment, valves, and related items.
  - 5. Thrust restraint calculations signed and sealed by a Professional Engineer licensed in the state where the project is to be constructed.
- D. Material Certificates:
  - 1. Certificate of Compliance with all applicable and appropriate reference standards certifying that all pipe, fittings, and specials, and other products and materials furnished, comply with the applicable provision of the Specification.
  - 2. Certification of Adequacy of Design: The Certificate of Adequacy of Design shall show the necessary provisions required in the design of the pipe to comply with applicable sections of this Specification. A Professional Engineer registered in the state where the Project is located shall seal the Certificate of Adequacy of Design.
- E. Field quality-control test reports.



## 1.5 PROJECT REQUIREMENTS

### A. Restrained Pipe and Fitting Joints, Buried Piping:

1. Restrained joints shall be used for a sufficient distance from each bend, tee, elbow, plug, or other fitting to resist thrust that will develop at the design pressure. Unless otherwise indicated on the drawings, the CONTRACTOR shall use mechanical restrained pipe joints and fittings (no thrust blocks).
2. CONTRACTOR shall provide restraint length calculations in accordance with AWWA M23 based on the laying conditions, soil conditions, depth of cover, and pressures to determine the number of restrained joints that will be required. The calculations shall be performed and sealed by a Professional Engineer in the state where the Project is being constructed.
3. For the purposes of thrust restraint, design pressures shall be the working pressure shown, plus the additional surge allowance for potable water, service water, and pump discharge piping. The design pressure shall be 1.5 times the design test pressure indicated for all other piping.
4. CONTRACTOR shall bear all costs for the restraint length design/calculations and will not receive reimbursement from the OWNER.

## PART 2 - PRODUCTS

### 2.1 PVC PIPE AND FITTINGS, 6-INCH THROUGH 48-INCH, PRESSURE

- A. PVC Pressure Pipe: AWWA C900, Class 150 and/or Class 200 (as shown on Drawings or in Pipe Schedule), with bell end with gasket, and with spigot end.
1. Comply with UL 1285 for fire-service mains if indicated.
  2. PVC Fabricated Fittings: AWWA C900, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110 or C153 ductile iron glands, rubber gaskets, and 316 stainless steel bolts with epoxy coating per AWWA C116.
    - a. Gaskets: AWWA C111, rubber.
  5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C110 or C153, ductile- or gray iron glands, rubber gaskets, and 316 Stainless Steel Bolts.
  6. PVC Integral Joint Restraint System:
    - a. Integral joint restraint system located in the bell designed for integration into PVC pipe manufactured to AWWA C900 and performance when tested in accordance with ASTM F1674.
    - b. Consists of a ductile iron casing that sits adjacent to the ASTM F477 gasket in the bell; casing is molded into the raceway of the bell during pipe belling; and a ductile iron grip-ring is inserted into the casing after factory hydro-testing.
    - c. Available Manufacturer: BullDog™ Integral Joint Restrain System.
  7. PVC Mechanical Joint Restraint System:
    - a. EBAA IRON Megalug Series

- b. Or approved equivalent

## 2.2 PVC PIPE AND FITTINGS, 6-INCH AND SMALLER, PRESSURE

- A. PVC Pipe and Fittings: ASTM D 1785, Schedule 40 and Schedule 80 pipe, with plain ends for solvent-cemented joints or threaded ends conforming to ASTM D 2466, Schedule 40 or ASTM D 2467, Schedule 80, socket-type or threaded fittings. Use Schedule 80 for all pipes to be threaded. Use Schedule 80 for all pipes to be threaded.
- B. Solvent Cement: As recommended by the pipe and fitting manufacturer conforming to D2564 for PVC piping systems and ASTM F493 for CPVC piping systems.

## 2.3 PVC PIPE AND FITTINGS, GRAVITY SEWER AND DRAIN

- A. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness pipe with ASTM D 3034, SDR 26, socket-type fittings for solvent-cemented joints.
- B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- C. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- D. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

## 2.4 JOINING MATERIALS

- A. Refer to Division 40 Section "Piping System, Basic Materials and Methods" for commonly used joining materials.
- B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

## 2.5 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
  - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
    - a. Standard: AWWA C219.

## 2.6 CORROSION-PROTECTION PIPE FITTINGS ENCASEMENT

- A. Encasement for Underground Metal Pipe Fittings: ASTM A 674 or AWWA C105.
  - 1. Form: Sheet or tube.
  - 2. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
  - 3. Color: Black.

## 2.7 INSTALLATION, CLEANING, AND TESTING

- A. Piping shall be leakage tested in accordance with Division 01 Section 01 45 00 "Quality

Control".

2.8 PIPING SCHEDULE

A. Piping Schedule shall as shown on the Drawings.

PART 3 - EXECUTION (NOT USED)

**END OF SECTION**

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**SECTION 40 05 00**  
**GENERAL REQUIREMENTS FOR PLANT AND STATION PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. All exposed, submerged and buried plant and station piping including modifications to existing systems as well as new pipe systems.
- B. Potable water mains, sanitary sewers, force mains, storm drains and culverts shown on Drawings.

**1.2 RELATED WORK**

- A. Section 01 33 10 – Supplier’s Submittals
- B. Section 09 91 00 – Painting and Protective Coatings
- C. Section 31 23 33 – Trenching, Backfilling and Compacting.
- D. Division 40 – Pipe and Fitting Sections and Pipe Testing Requirements.

**1.3 DESCRIPTION OF PIPING SYSTEMS**

- A. The configuration and layout of yard and station piping systems are shown in the Drawings. The existing piping systems are shown based on identifiable points and the previous project construction plans. CONTRACTOR shall identify existing piping locations and elevations in the vicinity of construction and notify the ENGINEER of conflicts prior to ordering materials.
- B. The type of pipe and joints, and embedment (if buried) to be used for each system are shown on the drawings or included in the appropriate specifications.
- C. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be the CONTRACTOR's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to provide restraints and anchor all piping, in accordance with the requirements set forth herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves.
- D. Pipe and fittings shown on yard piping drawings are general in nature. CONTRACTOR shall determine exact lengths and fittings required and make field adjustments necessary to complete piping and avoid conflicts. Changes to Plans and profiles of piping shall be submitted to ENGINEER for approval. Pipe and fittings not incorporated into the project shall remain the property of the CONTRACTOR. Costs will not be paid by the OWNER for materials not used in the project, even if shown on the drawings. Additions and deletions to the scope shall be incorporated by Change Order.
- E. Existing systems which must be removed for construction shall be replaced and re-installed at no additional cost to OWNER, at approximate location and elevation found, using the same type and class of pipe as found and per the embedment and backfill details in these plans. Support and protect existing piping to the extent possible.

**1.4 SHOP DRAWINGS AND PRODUCT DATA:**

- A. Comply with the provisions of Section 01 33 10 and the supplemental requirements below.
- B. Submit detailed layout drawings for all piping systems. Those drawings may be organized by

system or by areas. Prepare drawings to scale and show the following information on them:

1. Type of piping including material, weight, linings, and coatings. If desired, use code and key to product data sheet specified below.
  2. Location and type of joints, fittings, taps, supports, restraint systems, kickers and blocking (as applicable).
    - a. Submit fabrication drawings for specials including fabricated fittings, wall pipes and wall sleeves. Show dimensions and materials of construction.
    - b. Submit manufacturer's standard drawings showing dimensions, configuration and materials of construction for the following items:
      - 1) Joints.
      - 2) Flanges.
      - 3) Couplings.
      - 4) Expansion joints.
      - 5) Hangers, brackets and other similar accessories.
    - c. Submit the following product data on all piping materials.
      - 1) Reference standard.
      - 2) Type material.
      - 3) Wall thickness, schedule or class as appropriate.
      - 4) Outside diameter.
      - 5) Type and thickness of lining.
      - 6) Pressure rating, if applicable.
      - 7) Type and thickness of coating.
- C. Affidavits of Compliance:
1. Submit manufacturer's affidavits of compliance with the reference standards.
- D. CONTRACTOR shall mark actual flowline or top of pipe elevations and actual coordinates on record drawings when pipelines are being installed.

#### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. General: Comply with manufacturer's instructions.
- B. Delivery and Handling:
1. Do not deliver piping materials to project site prior to ENGINEER's approval of required submittals.
  2. Unload and handle piping materials using proper materials handling equipment.
  3. Do not drop, roll, skid piping materials.
  4. Take such additional precautions as necessary to avoid damaging piping materials and coatings thereon.
- C. Storage:
1. Store piping materials in a manner, which will reduce risk of damage, contamination, or corrosion. Piping materials will not be stored directly on the ground it shall be palletized or blocked.
  2. Scotch piping materials to prevent rolling or falling.
  3. Protect materials from weather, sun, dust or other contaminants as recommended by

the manufacturer or referenced documents.

#### 1.6 WORK AFFECTING EXISTING LINES

- A. Notify OWNER prior to interrupting flow in existing lines to make connections, to install temporary plugs or diversions, or for other reasons. Do not take existing lines out of service without specific authorization from the OWNER. The length of time allowed for interruptions will be minimal, and it is probable that the hour of the day approved for interrupting flow will be in the early morning hours.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. See other Sections in Division 40 for piping materials specifications.
- B. No asbestos materials shall be used in any piping materials, linings, and gaskets for this project.
- C. PVC piping shall not be used beneath structures except for chlorine gas or solution. Where PVC pressure pipe is called out for a system, furnish DIP for 4 inches and larger sizes. Transition 3 feet outside slabs and 1-foot above slabs unless otherwise shown. All piping beneath slabs and to 1-foot outside of slab shall be concrete encased.
- D. Gravity drain systems beneath slabs shall be ductile iron or cast iron soil pipe. Exposed drain system piping shall be PVC or cast iron.
- E. All buried raw water piping installed in this project shall have tape indicating "Raw Water Line" installed 12 inches above the pipe.
- F. Install cleanouts on sludge and scum piping so that all runs between bends may be accessed and at intervals not exceeding 250 feet on straight runs. Refer to Standard details.

### PART 3 - EXECUTION

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install all piping systems in accordance with the Drawings, Technical Specifications, approved shop drawings and manufacturer's installation instructions.
- B. Examine all piping materials prior to installation and replace items that are damaged or otherwise defective.
- C. Thoroughly clean inside of all piping, valves, and accessories, and outside of all materials which will be exposed. Clean before installation and maintain in that condition until coated or final acceptance of project.
- D. Provide temporary caps or plugs over all pipe openings at the end of each day to prevent foreign material from entering the piping systems.
- E. Do not modify structures, equipment, or piping for the purpose of installing piping unless specifically authorized by the ENGINEER.
- F. All piping systems shall be cleaned and tested prior to making connections at structures and to existing pipe systems. Small diameter pipes shall be flushed and large diameter pipes shall have mandrels pulled or other acceptable verification furnished that pipes are clean and no construction debris remains. Temporary blocking and forms used to grout inverts and blockouts shall be removed before payment will be approved for the last 10 percent of

the respective pipe pay estimate items.

- G. CONTRACTOR shall be responsible for, develop, and comply with the trench safety plan and a confined space entry plan. The CONTRACTOR is cautioned that the existing facilities are in operation. Raw wastewater, sludge, scum, and drain pipes, and manholes may exhibit H<sub>2</sub>S and methane gases, as well as oxygen deficient conditions.

### 3.2 INSTALLATION OF BURIED PIPING SYSTEMS

#### A. Line and Grade:

1. Install piping to lines and grades shown on Drawings.
2. Slope piping uniformly between flowline elevations shown.
3. If centerline and flowline elevations are not shown on Drawings, install piping so that there is at least 4 feet of cover over same, except under ditches where the minimum cover is to be 24 inches. Piping less than 4-inch diameter may be installed with 3 feet of cover.
4. Comply with requirements for minimum and maximum trench widths shown in the plans. If maximum trench width is exceeded, use next higher class of embedment at no additional cost.

#### B. Dewatering:

1. Keep trenches free of water when performing any type of work in them.
2. Discharge groundwater from construction pumps as directed by Owner.

#### C. Bedding:

1. Install bedding as shown on Drawings. Shape bedding to allow for coupling and bells and to provide support over full length of pipe section. Place embedment under haunches and on sides of pipe and compact in lifts and in a manner which does not disturb pipe from line and grade.
2. If bedding is not called for on Drawings or Specifications, piping less than 4-inch diameter shall be installed and encased in sand or granular material. Use embedment type shown in the standard details for larger pipes.
3. Provide concrete encasement for all pipe under structures and to 2' beyond structure and as shown on drawings.
4. Provide concrete cradle (Class V) Embedment to first pipe joint at all connections to structures unless otherwise shown.

#### D. Laying of Pipe:

1. Do not drop or roll pipe into trench. Inspect thoroughly prior to laying and then place carefully by hand or materials handling equipment.
2. Do not lay pipe in water.
3. Lay bell and spigot type piping with bell end facing direction of laying which is normally upgrade.
4. Joint pipe as specified in piping material specifications.
5. Do not deflect pipe unless shown on Drawings or approved by ENGINEER.
6. When deflection of pipe is authorized, do not exceed the manufacturer's recommended maximum deflection.
7. Shoring or other trench safety systems utilized shall be of thin cross-section such that



when the sections are pulled, the embedment is not disturbed or displaced.

E. Encasement of Piping and Valves:

1. Provide polyethylene encasement for buried cast iron and ductile iron piping and valves.
2. Encapsulate all buried flanges, valves, and couplings in wax tape. Utilize suggested primer and profiling mastic to create smooth profile for wax tape.
3. Provide sand encasement for PVC pipe unless otherwise shown.
4. Sand encasement to extend at least 6-inches above pipe and 3-inches below pipe.
5. Use Class C concrete or flowable fill when concrete encasement is called for on Drawings. Such encasement to extend a distance of Pipe OD/6 with a minimum of 6 inches from pipe in all directions unless otherwise noted on drawings.

F. Concrete Blocking:

1. Concrete thrust blocking may be used for all buried piping 6-inches in diameter and smaller that is under pressure. All piping larger than 6-inch size shall utilize mechanical restraint systems.
2. Locate thrust blocks at all bends, tees, wyes, hydrants, and plugs.
3. Use Class C concrete.
4. Place concrete against undisturbed firm earth.
5. Area of concrete in contact with earth to be as required to prevent pipe movement at specified field test pressure.
6. Indicate thrust blocking locations on Record Drawings.

G. Restrained Joints:

1. Use restrained joint piping and fittings for all pipe 8-inches and larger that is under pressure and when called for on Drawings.
2. Restrained joints may be used in lieu of concrete blocking for pipes smaller than 8 inches.
3. Type of restraining system and number of restrained joints shall be designed by pipe supplier and submitted for review.

H. Backfilling:

1. Comply with Section 31 23 33 and the following supplemental requirements.
2. Backfill as soon as practicable after installation of piping, valves, encasement, restraint and blocking.
3. Touch up damaged protective coatings prior to backfilling.
4. Exercise care to avoid damaging piping or protective coatings with tamping equipment.
5. When authorized by the ENGINEER, sheeting and bracing may be left in trench. Cut off all members so that tops of same are at least 18 inches below ground. Sheeting and bracing left in place shall be indicated on Record Drawings.

I. Making Connections to Existing Manholes:

1. Cut neat opening in manhole no larger than necessary to insert new line.
2. Utilize PVC sleeves with rubber gaskets and abrasive silica outer coating. After installing new lines, place concrete collar around pipe on outside of manhole to seal

joint. Make collar approximately 8 inches wide by 8 inches deep. Use Class B concrete.

3. Modify invert channel in manhole to provide smooth transition into or out of new pipe. Use Class B concrete.

J. Connections and New Manholes

1. Couplings for pipe connections shall be cast into the manhole walls (FERNCO or approved equal). PVC sleeves with rubber gaskets and abrasive silica outer coating may also be utilized.
2. All clamps shall be 316 stainless steel.
3. Support manhole connection to first pipe joint with concrete cradle.

K. Testing

1. Comply with Section 01 45 00 and pipe specifications and drawings.

### 3.3 INSTALLATION OF EXPOSED PIPING SYSTEMS

A. Alignment and Elevation:

1. Install straight runs true to line and elevation.
2. Install vertical pipe truly plumb in all directions.
3. Install piping parallel or perpendicular to building walls. Piping at odd angles and 45 degree runs across corners will not be accepted unless specifically shown on Drawings.
4. Install small diameter piping generally as shown on Drawings when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, etc.
5. Install piping so that pipe, flanges, valves, and associated appurtenances are at least eight feet above finish floors, stairs, and landings unless lesser clearances are specifically dimensioned on the Drawings.
6. Bring piping to alignment and elevation without forcing or springing pipe.

B. Joints:

1. Joint pipe in accordance with piping material specifications and the supplemental requirements below.
2. Wire brush flange faces and threads before jointing.
3. Bring piping to proper alignment and elevation with permanent support system before tightening flange bolts and nuts.

C. Unions for Threaded Piping:

1. Install unions near threaded valves and equipment to facilitate assembly and disassembly of piping, in addition to the specific locations shown on plans.
2. Install dielectric unions wherever dissimilar metals are joined.

D. Expansion Joints:

1. Install in accordance with Drawings, specifications for expansion joints and approved shop drawings.
2. Use of additional couplings and adaptors to be approved by ENGINEER prior to installation.

- E. Flexible Couplings and Flanged Coupling Adaptors:
1. Install in accordance with Drawings, specifications for couplings and adaptors, and approved shop drawings.
  2. CONTRACTOR may use couplings and adaptors over and above those shown on Drawings to facilitate installation of piping. Use of additional couplings and adaptors to be approved by ENGINEER prior to installation.
- F. Piping Supports and Restraints:
1. General:
    - a. Restrain, block, brace, support, or suspend pipe and fittings to prevent displacement, vibration, sagging, warping, deformation, or failure of piping and fittings, and to allow for expansion and contraction.
    - b. Support and restrain piping so that no piping loads from weight or thrust will be imparted to pumps or other equipment.
    - c. Materials: Unless otherwise specified, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the structural steel section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.
    - d. Unless otherwise specified or indicated on the drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.
    - e. Except as specified herein, the use of supports which rely on stressed thermoplastic components to support the pipe will not be acceptable. PVC pipe 4 inches and smaller, interior locations, may be supported by pultruded vinylester channel and components as specified below:
      - 1) Material: Vinylester Fiberglass, Class 1 Fire Rated per ASTM E-84, Premium Grade, Poltruded channel as manufactured by Entrum Industries, Strut Tech Series 200 or equal. Support system shall be as specified herein and as recommended by the manufacturer.
      - 2) Adjustable strap type pipe clamps are not acceptable. Any metal components, if required, for this type support system shall be Type 316 stainless steel.
    - f. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Supports for brass or copper pipe or tubing shall be copper plated. Those portions of pipe supports which contact other dissimilar metals shall be rubber or vinyl coated.
    - g. All pipe supports, fasteners, anchors and hardware shall be AISI Type 316 stainless steel. Stainless steel supports fabricated by welding shall be AISI Type 316L material.
- G. Supports for Horizontal Piping and Spacing of Expansion Joints:
1. Location: Unless closer spacing is indicated on the drawings, the maximum spacing for pipe supports and expansion joints shall be:

<b>Type of Pipe</b>	<b>Pipe Support Maximum Spacing (FT)</b>	<b>Expansion Joint Max Maximum Spacing (Note b, FT)</b>
---------------------	--------------------------------------------------	-----------------------------------------------------------------

Ductile iron	15	80
Copper for other services		
1-inch and smaller	5	--
Over 1-inch	7	100
CPVC/PVC, Schedule 80		
1/8- and 1/4-inch	Continuous Support	60
1/2-inch	3-1/2	60
3/4-inch	4	60
1- and 1-1/4-inch	4-1/2	60
1-1/2- and 2-inch	5	60
2-1/2-inch	5-1/2	60
3-inch	6-1/2	60
4-inch	7	60
6-inch	8	60
8-inch	9	60
10-inch	9-1/2	60
12-inch	10	60

NOTES:

- (a) Unless otherwise permitted, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
  - (b) Unless otherwise permitted, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
  - (c) Expansion joint fittings shall be as specified in the pipe joint and expansion joints section.
  - (d) Correction factors shall be applied to the above table as recommended by the manufacturer to adjust for fluid specific gravities other than 1.0.
  - (e) Maximum allowable spacing for PVC pipe shall be reduced when required by manufacturer's recommendations for maximum fluid temperatures.
2. Locate hangers or supports immediately adjacent to or at any change in piping direction, and on both sides of valves, couplings, and heavy fittings, unless specifically noted otherwise on Drawings.
  3. Install all hangers and supports so as not to interfere with the free expansion and contraction of the pipe.
  4. When hangers are used to support insulated piping, provide shields to protect insulation.
  5. Provide concrete supports as shown on Drawings, or when required to comply with these specifications. Construct in accordance with concrete specifications and details shown on Drawings.
  6. Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

7. Unless otherwise indicated on the drawings or permitted by the ENGINEER, piping shall be supported approximately 1-1/2 inches out from the face of walls and at least 3 inches below ceilings.
  8. Concrete inserts or L-shaped anchor bolts shall be used to support piping from new cast-in-place concrete. Capsule anchors shall be used to fasten supports to existing concrete and masonry. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.
  9. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item.
  10. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.
  11. Pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required when mechanical couplings are permitted as expansion joints. Guides shall be placed on both sides of expansion joints except where anchors are adjacent to the joint. Unless otherwise indicated on the drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for support. Pipe guides shall be installed as recommended by the manufacturer.
- H. Drain Valves and Air Bleed Valves:
1. Provide drain petcocks 1/4-inch diameter opening at all low points.
  2. Provide air bleed valves 1/8-inch diameter opening at all high points unless specifically indicated otherwise.
- I. Supports for Vertical Piping:
1. Support in accordance with Drawings and approved shop drawings.
  2. For piping four inches and smaller, install riser clamps so as to support piping at each floor sleeve.
  3. Use at least 3/4 inch of nonshrink grout in setting base elbows and tees. See the Structural General Notes on Sheet S-100 for nonshrink grout requirements.
  4. For piping larger than 4 inches, locate supports at change of direction, at both sides of valves and couplings, and at maximum spacing of 10 feet.
- J. Piping Restraints:
1. Provide kickers and mechanical restraint system as shown on Drawings and required herein.
  2. Use at least 3/4 inch of nonshrink grout between kickers and walls or floors and between piping supports and floors or walls unless otherwise shown on Drawings. See Section 03 60 00, Nonshrink Grout, for nonshrink grout requirements.
- K. Supports for Valves:

1. Provide supports for valves 16 inches and larger. Use the type of support shown on Drawings. If type is not shown, use concrete cradle type. CONTRACTOR may utilize an alternate type if acceptable to the ENGINEER.
  2. Install floor stands as shown on Drawings and as recommended by the manufacturer.
  3. Provide lateral restraints for extension bonnets and extension stems as shown on Drawings and as recommended by the manufacturer.
  4. Provide sleeves where operating stems pass through floor.
  5. Place approved asphalt fill in recessed areas as shown on Drawings where flush bottom sluice gates or special valve installations are indicated. Size recessed areas as recommended by valve or gate manufacturer. Compact fill after placement.
  6. Install valve boxes so that they will not transmit shock or stress to valve and will be centered and plumb over the operating nuts.
- L. Wall Fittings:
1. Wall fittings shall be as shown on the plans and the standard detail sheets.
  2. Wall fittings shall match the wall thickness, pipeline diameters, and connection types specified for the applicable pipeline designation.
- M. Field Painting:
1. Comply with Section 09 91 00.
  2. Buried Piping: Ductile iron, cast iron and steel coatings per Division 40 as applicable.
  3. Exposed Piping: Paint all exposed piping, supports, fittings and valves except stainless steel and fiberglass in accordance with Section 09 91 00.
- N. Pipe Testing.
1. Comply with Section 01 45 00 and pipe specifications.
- O. Insulation and Heat Trace
1. Insulate all exposed pipes and furnish heat tracing on all exposed pipes 4-inch and smaller and where specifically called for on the plans.

**END OF SECTION**

**SECTION 40 05 05**  
**BASIC MECHANICAL REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 40.

**1.2 SUMMARY**

- A. This Section includes general procedural requirements for mechanical installations.

**1.3 REFERENCE STANDARDS**

- A. Materials specified by reference to standards of ASTM, ANSI, AWWA, ASME, ODOT, Federal, or other standard organizations must comply with latest edition (except where specified otherwise in individual sections by noting year or edition) in effect on date bids are received.
- B. Requirements in referenced standards established minimum requirements for all equipment, materials, and work. For instances where capacities, size, or other feature of the equipment, devices, or materials exceed these minimums, meet the listed or requirements specified in the Drawings and Specifications.

**1.4 CODE REQUIREMENTS AND PERMITS**

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
- B. Resolve code violations discovered in Contract Documents with ENGINEER prior to award of Contract. After award of Contract, CONTRACTOR shall make any correction or addition necessary for compliance with applicable codes at no additional cost to OWNER.
- C. CONTRACTOR shall obtain and pay for all permits and licenses, pay all fees, and obtain all certificates of inspection and other permits required to place Work in operation.

**1.5 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to the applicable code for the materials and work involved:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code – Steel"
  - 2. AWS D1.2/D1.2M, "Structural Welding Code – Aluminum"
  - 3. AWS D1.3, "Structural Welding Code - Sheet Steel"
  - 4. AWS D1.4, "Structural Welding Code - Reinforcing Steel"
  - 5. AWS D1.6, "Structural Welding Code – Stainless steel"
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Welding procedures and testing shall comply with ANSI B31.1.0, "Standard Code for Pressure Piping, Power Piping," and the AWS Welding Handbook.
- D. Soldering and Brazing Procedures shall conform to ANSI B9.1, "Standard Safety Code for Mechanical refrigeration."

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## PART 2 - PRODUCTS (NOT APPLICABLE)

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

#### A. Obstructions:

1. The Drawings for work associated with existing facilities, indicate certain information pertaining to surface and subsurface obstructions obtain from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
2. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations of existing work have been given.
3. Should obstruction be encountered, whether shown or not, after routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing service, structures, and facilities in a satisfactory and serviceable conditions.
4. Assume responsibility for and repair any damage to existing utilities, structures, or facilities, whether or not such existing facilities are shown on the drawings.

#### B. Rough In:

1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
2. Refer to equipment specifications in Division 5 through Division 40 for rough-in requirements.

#### C. Job Conditions:

1. Examine the areas and conditions under which the Work will be performed.
2. Where ducts, pipes, and other mechanical work are shown in conflict with locations of structural members, electrical, other equipment and related items, include labor and materials required for extensions, offsets, and supports to clear the encroachments.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation.
4. Verify all dimensions and distances. No additional compensation will be allowed because of differences between work shown on the Drawings and actual dimensions and distances at the jobsite.

#### D. Preparation and Coordination With Other trades:

1. Perform coordination work associated with the Mechanical sections of Division 15 through Division 40 in accordance with provisions of specifications, shop drawings, and Drawings, as well as the following:
  - a. Coordinate as necessary with other trades to assure proper and adequate interface with all the Work.



- b. Coordinate accepted equipment changes from those scheduled or specified with other trades affected. Additional compensation to other trades for equipment changes are the responsibility of the contractor making the change.
2. The mechanical drawings are diagrammatic, but are required to be followed as closely as actual construction and work of other trades will permit. Duct and piping arrangement have been designed for maximum economy consistent with good practice and other considerations. Install the systems arranged as shown on the Drawings, except as otherwise approved in advance by the Owner's Representative.
3. Where items such as diffusers, thermostats, switches, control panels, and related work are not specifically located on the Drawings, locate as determined in the field by the Owner's Representative. When such items are installed without such specific direction, relocate as directed by the Owner's Representative and at no additional cost to the OWNER.

### 3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
  1. Coordinate mechanical systems, equipment, and materials installation with other building components.
  2. Verify all dimensions by field measurements.
  3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
  4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
  5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
  7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
  8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
  9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
  10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
  11. Install systems, materials, and equipment giving right-of-way priority to systems

required to be installed at a specified slope.

### 3.3 CUTTING AND PATCHING

#### A. General:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
2. Accomplished cutting and patching operations as described in the Specifications and in accordance with OWNER requirements.

#### B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Remove and replace Work not conforming to requirements of the Contract Documents.
2. Remove and relocate equipment and materials in existing structures.

#### C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

### 3.4 DEMOLITION

- #### A.
- When designated on the Drawings, accomplish demolition of equipment, structures, facilities, and related work in accordance with the Division 2 Section 02 41 19 "Selective Demolition," if applicable.

**END OF SECTION**

**SECTION 40 05 14**  
**PIPE COUPLINGS AND EXPANSION JOINTS**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Flexible couplings, flange coupling adapters, insulated transition couplings, dismantling joints, expansion joints, and restraining hardware for above items.

**1.2 QUALITY ASSURANCE**

- A. Factory Assurance:
  - 1. Test each item for mechanical and material defects per manufacturer's standard practice.
  - 2. Hydrostatically test each item to 150 percent of its maximum allowable working pressure.

**1.3 SUBMITTALS**

- A. Shop Drawings, Product Data and Samples:
  - 1. Comply with the general requirements of Section 01 33 00 and supplemental requirements below.
- B. Submit the following items for each type flexible coupling, flanged coupling, adaptor, and expansion joints.
  - 1. Description and illustration of construction.
  - 2. List of materials.
  - 3. Description of factory-applied protective coatings.
  - 4. Dimensions.
  - 5. Pressure rating.
  - 6. For expansion joints only, the movement, force, and spring rate capabilities.
  - 7. Shop drawings for restraining systems such as tie bolt assemblies. Drawings to show layout, dimensions, number and size of bolts, and lug details.
  - 8. Manufacturer's installation instructions.
  - 9. Manufacturer's epoxy lining and coating system for wastewater application including certificate of approval for wastewater. Catalog cuts and other information for all products proposed.
- C. Product data described in the previous paragraph may be submitted in the form of catalog bulletins or other standard manufacturer literature and drawings as long as all the data specified are furnished. If catalog bulletins are submitted, they are to be marked up to show the styles, options, and other data which are applicable.
- D. If CONTRACTOR elects to use more couplings and expansion joints than are shown on Drawings, submit piping layout drawings showing the location of each proposed additional unit and describing the type of each such unit. Use of additional units is subject to ENGINEER's approval.

**1.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Comply with the requirements of the General Conditions.

## PART 2 - PRODUCTS

### 2.1 FLEXIBLE COUPLINGS

- A. Flexible couplings to be mechanical compression type with sleeve two end rings, center ring, two resilient wedge-shaped gaskets, and a set of bolts and nuts to draw the two follower glands together. Shall include insulating boot when connecting two dissimilar metals.
- B. Construction:
  - 1. Center ring: Carbon steel
  - 2. End rings: Carbon steel
  - 3. Gaskets:
    - a. Resilient rubber compound suitable for sewage service.
    - b. Meets requirements of AWWA C219 and ASTM D2000
  - 4. Insulating Boot:
    - a. EPDM
  - 5. Bolts and nuts:
    - a. 304 Stainless Steel. Nuts shall be PTFE coated.
    - b. Number and size as required for size and type coupling and as recommended by manufacturer for test pressure.
  - 6. Working pressure of 100 psi
- C. Factory Painting:
  - 1. Apply epoxy-type protective coating system to interior and exterior of couplings including center ring. Coating to be manufacturer's epoxy system suitable for wastewater service complete with prime and finish coats.
  - 2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- D. Manufacturer and Model:
  - 1. Romac Industries – Style 400RG
  - 2. Or approved equivalent.

### 2.2 FLANGED COUPLING ADAPTERS

- A. Flanged coupling adapters to consist of a body or sleeve with pipe flange on one end and compression-type coupling on the other end. Compression coupling to consist of follower, resilient wedge-shaped gasket, and a set of bolts to draw follower against gasket. All flanged coupling adapters shall include restraining systems unless otherwise noted on drawings.
- B. Construction:
  - 1. Body and follower: Epoxy Coated Carbon Steel
  - 2. End rings: Epoxy Coated Carbon Steel
  - 3. Flange: ANSI Class 125 or 250 flat face. Match class to that of piping system.
  - 4. Gasket:
    - a. Resilient rubber compound suitable for sewage service.
    - b. Meets requirements of AWWA C219 and ASTM D2000
  - 5. Bolts and nuts:

- a. 304 Stainless Steel. Nuts shall be PTFE coated.
  - b. Number and sized to suit specified piping system test pressure.
- 6. Working pressure of 100 psi
- C. Restraining System:
  - 1. Restraining or harnessing system to be as specified for flexible couplings
- D. Factory Painting:
  - 1. Apply epoxy-type protective coating system to interior and exterior of couplings including center ring. Coating to be manufacturer's epoxy system suitable for wastewater service complete with prime and finish coats.
  - 2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- E. Number and size for tie bolts and anchor studs or locking pins to suit specified piping system test pressure. Minimum of two diametrically opposed restraints required for restrained adapters.
- F. Manufacturer and Model:
  - 1. Romac Industries – Model RFCA
  - 2. Or approved equivalent.

### 2.3 INSULATED STEEL TRANSITION COUPLING

- A. The insulated steel transition coupling shall consist of a body or sleeve with compression-type couplings on each end. Compression coupling to consist of follower, resilient wedge-shaped gasket and a set of bolts to draw the follower against the gasket. On one end, the gasket will extend beyond the end of the pipe preventing any metal-to-metal contact. The coupling shall allow for the joining of different outside diameters of pipe.
- B. Construction:
  - 1. Body and follower: ASTM A53C Carbon Steel
  - 2. End rings: AISI C 1020 Carbon Steel or ASTM A-536 Ductile Iron
  - 3. Gasket:
    - a. Resilient rubber compound suitable for sewage service.
    - b. Meets requirements of AWWA C219 and ASTM D2000
  - 4. Insulating Boot:
    - a. Buna-N
  - 5. Bolts and nuts:
    - a. 304 Stainless Steel. Nuts shall be PTFE coated.
    - b. Number and sized to suit specified piping system test pressure.
  - 6. Working pressure of 100 psi
- C. Factory Painting:
  - 1. Apply epoxy-type protective coating system to interior and exterior of couplings including center ring. Coating to be manufacturer's epoxy system suitable for wastewater service complete with prime and finish coats.
  - 2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- D. Manufacturer and Model:

1. Smith-Blair Style 417
2. Or approved equivalent.

#### 2.4 SLEEVE TYPE COUPLING

- A. The sleeve type coupling shall be a joint restraint to prevent axial separation between two plain ends of same or dissimilar materials. (Internal pipe wall stiffeners shall be used when restraining HDPE.) The coupling shall incorporate individually actuating gripping surfaces to restrain, and have torque limiting twist off nuts.
- B. Construction:
  1. Body: ASTM A536 Ductile Iron
  2. End rings: AISI C 1020 Carbon Steel or ASTM A-536 Ductile Iron
  3. Gasket:
    - a. Resilient rubber compound suitable for water service.
    - b. Meets requirements of AWWA C219, AWWA C111/A21.11, and ASTM D2000
  4. Bolts and nuts:
    - a. 304 Stainless Steel. Nuts shall be PTFE coated.
    - b. Number and sized to suit specified piping system test pressure.
  5. Working pressure of 150 psi
- C. Factory Painting:
  1. Apply epoxy-type protective coating system to interior and exterior of couplings including center ring. Coating to be manufacturer's epoxy system suitable for wastewater service complete with prime and finish coats.
  2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- D. Manufacturer and Model:
  1. EBAA Iron Series 3800
  2. Or approved equivalent.

#### 2.5 DISMANTLING JOINT

- A. Dismantling joint to consist of a body or sleeve with pipe flange on one end and a separate flanged coupling body with an end ring. A resilient wedge-shaped gasket is located between the end ring and the flanged coupling body and is compressed using bolts to draw the end ring against the flange. All dismantling joints shall include tie rods unless otherwise noted on drawings.
- B. Construction:
  1. Flanged Spool: AWWA C207 Class D
  2. End Ring and Body: ASTM A536 Ductile Iron
  3. Gasket:
    - a. Resilient rubber compound suitable for sewage service.
    - b. Meets requirements of AWWA C219 and ASTM D2000
  4. Bolts and nuts:
    - a. 304 Stainless Steel. Nuts shall be PTFE coated.
    - b. Number and sized to suit specified piping system test pressure.

5. Tie Rods: 304 Stainless Steel
  6. Working pressure of 100 psi
- C. Factory Painting:
1. Apply epoxy-type protective coating system to interior and exterior of couplings including center ring. Coating to be manufacturer's epoxy system suitable for wastewater service complete with prime and finish coats.
  2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- D. Manufacturer and Model:
1. Romac Industries – Model DJ400
  2. Or approved equivalent.

## 2.6 VICTAULIC AGS COUPLING

- A. Victaulic Advanced Groove System (AGS) coupling to consist of a split-ring body with an interior gasket to seal over the joining end of each pipe.
- B. Construction:
1. Split Ring: ASTM A536 Ductile Iron
  2. Gasket:
    - a. Grade “T Nitrile
  3. Bolts and nuts:
    - a. 316 Stainless Steel. Nuts shall be PTFE coated.
    - b. Number and sized to suit specified piping system test pressure.
  4. Working pressure of 100 psi
- C. Factory Painting:
1. Fusion Bonded Epoxy Coating
  2. All surfaces except for bolts, nuts, and gaskets shall be epoxy coated and lined.
- D. Manufacturer and Model:
1. Victaulic AGS Flexible Coupling – Style W77

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
1. Inspect each coupling, adaptor, and expansion joint for damage and defects before installation and replace defective items.
  2. Install each item in accordance with the Drawings, TECHNICAL SPECIFICATIONS, approved piping layout shop drawings, and approved manufacturer’s installation instructions.
  3. CONTRACTOR may provide additional flexible couplings, flanged coupling adapters, and expansion joints over and above those shown on Drawings to facilitate installation of piping.
    - a. Use of such additional items is to be approved by the ENGINEER prior to installation.

- b. Additional joints are to be at no expense to the OWNER.
  - 4. Verify that inside diameters of flexible couplings and flanged coupling adapters are compatible with outside diameters of piping with which couplings or adapters are being used.
- B. Flexible Couplings:
- 1. Clean and lubricate pipe ends before installation.
  - 2. Leave a gap between the pipe ends to permit pipe expansion and increase flexibility of the joint. Gaps between pipe ends to be approximately as follows:
    - a. 12-inch diameter and smaller: 1-inch ±.
    - b. 14-inch diameter through 36-inch: 1-1/2-inch ±.
    - c. Over 36 inches: 2-inch.
  - 3. Tighten bolts in manner and to torques prescribed by manufacturer.
- C. Field Painting:
- 1. Touch up factory finishes which have been damaged.
  - 2. Apply protective coating to bolts and nuts after tightening. Use same coating system as that specified for adjoining piping.
- D. Testing:
- 1. Joints are tested as a part of the overall piping system.
    - a. See Section 40 05 03.

**END OF SECTION**



**SECTION 40 05 78.13**  
**VALVES, AIR RELEASE AND VACUUM RELEASE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes the following valves for water and/or sewerage service:
  - 1. Combination air release and vacuum valves
- B. Related Sections:
  - 1. Refer to Divisions 1 and 33 for information regarding submittals; quality assurance; coordination; material delivery, handling, and storage; projection conditions; design requirements; other materials; installation of piping systems; field testing; and related work.

**1.3 STANDARDS**

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:
  - 1. American National Standards Institute (ANSI)/ NSF:
    - a. ANSI/NSF Standard 61
  - 2. American Water Works Associations (AWWA):
    - a. AWWA C512 – Air Release, Air/Vacuum and Combination Air Valves for Water Works Service.

**1.4 WARRANTIES**

- A. Contractor shall provide the Manufacturer’s standard warranty for all valves in the Section.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Vent-O-Mat
  - 2. Approved Equal

**2.2 GENERAL:**

- A. Standard: Manufactured and tested in accordance with AWWA C512 “Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.”
- B. Valves used in potable water service shall be certified to NSF 61 “Drinking Water Systems Components – Health Effects.”
- C. Valve End Connections: 1-inch and smaller, threaded; 2-inches and larger, flanged, ANSI B16.1, Class 125 for cast iron, Class 150 for ductile iron and stainless steel, or Class 250 as

required, unless otherwise noted.

- D. Valve and flange connections shall have a minimum working pressure of 150 psi.
- E. Valves shall be hydraulically tested at 1.5 times their rated cold water pressure.
- F. Exterior of valve shall receive a coating of universal metal primer which is FDA approved for potable water.

### 2.3 COMBINATION AIR VALVES, (CAV), 1-INCH THROUGH 12-INCH:

- 1. Description: Air release valves shall be surge dampening, slam preventing, automatic float operated valves designed to exhaust large quantities air during the filling of a piping system and open during draining or if a negative pressure occurs. It also shall release accumulated pockets of air while the system is in operation.
- 2. Materials: Body and cover constructed of AISI 316L Stainless Steel; orifice, special design float constructed of ASTM A240 T316 stainless steel or High Density Polyethylene; nozzle shall be AISI 316 SS and seat shall be EPDM or Buna-N; stainless steel fasteners.
- 3. Internals shall be removable through the top cover.
- 4. Valve size and options shall be as listed in the Valve Schedule.
- 5. Products:
  - a. Vent-O-Mat Series RBX (Model # 025 RBX 19 2 1 S6)

### 2.4 ACCESSORIES

- A. Shut-off Valve: For isolation of the valves from the piping, provide a full-ported, stainless steel ball valve for threaded inlets and AWWA Class 150B butterfly valve with quarter-turn gear actuator for flanged inlets.
- B. Options: When specified in the Valve Schedule one or more of the following options:
  - 1. Cross Contamination and Security Protection (CCSP): When valves installed in vaults or flood prone locations, provide an inflow preventer to prevent the introduction of contaminated water through the air valve outlet.
  - 2. Anti-Slam Device (ASD): Valves, 2-inch and larger, provide to prevent valve pressure surges due to column separation or rapid changes in velocity and pressure.
  - 3. Screen Outlet (SO): Provide a stainless steel screened outlet for outdoor locations.
- C. Identification: Provide valve identification tags in accordance with Division 10 Section 10 90 00 "Identification, Stenciling, and Tagging."
- D. Refer to Division 40 Section 40 05 00 for additional accessories and requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 40 Section 40 05 00 for execution requirements for the installation, field quality control, and manufacturer's services.

### 3.2 VALVE SCHEDULE

- A. Refer to Drawings for type, end connections, and locations for all valves.

**END OF SECTION**

**AIR RELEASE AND AIR/VACUUM VALVE SCHEDULE**

Mark	Pipeline #	Location (STA)	Type	Service	Size (Inches)	Orifice Size (Inches)	Pressure (psi)		Details
							Max.	Min.	
7	3" Wastewater	Lift Station	SCAV	Wastewater	1		200	5	Pump Discharge
8	3" Wastewater	Lift Station	SCAV	Wastewater	1		200	5	Pump Discharge
9	3" Wastewater	Lift Station	SCAV	Wastewater	1		200	5	Pump Discharge
10	3" Wastewater	Lift Station	SCAV	Wastewater	1		200	5	Future Pump Discharge
11	3" Wastewater	Lift Station	SCAV	Wastewater	1		200	5	Discharge Header

Type:

- AV = air release valve
- SAV = sewage air release valve
- AVV = air vacuum valve
- SAVV = sewage air/vacuum valve
- CAV = combination air vacuum valve
- SCAV = sewage combination air/vacuum valve
- CAVSC = combination air and vacuum valve with surge check
- VRV = vacuum relief valve

Orifice Size: Pertains to air release valves and single body combination valves.

**SECTION 40 05 92**  
**COMMON CONTROL PANEL REQUIREMENTS FOR PUMPING SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The intent of the specification is to establish requirements for the supply of a complete Vendor or Control Systems Integrator (CSI) furnished local pump control panel.
- B. Equipment Manufacturer or CSI shall furnish fully functional control panels to operate equipment as specified in Division 40, and in accordance with the contract drawings.
- C. Control Panel Objective
  - 1. Lift Station Pump Control - The panel will provide level-based control of one to four constant speed or VFD controlled pumps in a staging fashion with alternation. The pump stager calls for the pumps as needed based on level. The alternator determines which pump will run when the stager calls.
- D. SCADA Coordination
  - 1. Control Panels will be furnished with network devices to support remote indication and alarming of equipment over Ethernet IP or Modbus TCP
  - 2. Panel Supplier to furnish detailed Memory Maps and documentation package illustrating protocols, device configuration, memory access and port configuration
- E. All equipment, field devices and instruments shall follow naming conventions as shown on Contract Documents.
- F. All Control Panels shall have a UL 508A label affixed to the inside of the panel. Those panels with equipment or instrumentation in Class I, Division I areas shall also comply with UL 698.
- G. Related Sections include but are not necessarily limited to:
  - 1. 26 29 03 – Low Voltage Pilot Control Devices

**1.2 REFERENCES - NOT USED**

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Comply with the submittal requirements of Section 01 30 00 - Administrative Requirements, Individual Equipment Specifications, and as described below.
- B. Product Data: For each type of product indicated, include construction details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Panel Layout Drawings and Wiring Diagrams Submittal
  - 1. Panel Manufacture and Layout Drawings - At a minimum, the panel drawing package shall include the following:
    - a. Equipment Identification and Bill of Material (BOM)
    - b. Interior and exterior panel elevation drawings to scale and plotted on 11x17 inches.

- c. Nameplate schedule and conformance with UL508 UL labeling
  - d. Cabinet assembly and layout drawings to scale, with panel dimensions indicated
  - e. Fabrication and painting specifications
  - f. Construction details, NEMA ratings, hazardous area location information
  - g. Heating and cooling calculations for each panel including recommended equipment for both heating and cooling.
2. Panel Wiring Diagrams:
- a. Depicting wiring inside the panel
  - b. Connections to external or Field devices shown
  - c. Terminal blocks and numbering including terminal points where I/O wiring lands on equipment
  - d. Two-wire and four-wire equipment shall be clearly identified and power sources noted.
- D. Memory Map:
- 1. Submit memory map of PLC or Controller registers to be transmitted to SCADA System.
  - 2. Provide Device configuration information
  - 3. Provide protocol and port information
- E. Operation and Maintenance Data: For control panels, installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 - Operation and Maintenance Data, include the following:
- 1. Routine maintenance requirements for control panels and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 3. Final As-Built drawing shall be supplied in AutoCAD format, utilizing AutoCAD's eTransmit feature, for use by the OWNER in modifying panels for future expansion or required modifications.
  - 4. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
  - 5. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
  - 6. Configuration Settings: Compile after panel has been installed and tested, all configuration or program settings, of VFDs, meters, controllers, timers, etc. in documentation format.

## 1.5 QUALITY ASSURANCE

- A. The manufacturer of the control panels shall have produced similar equipment for a minimum period of five years.
- B. The control panels shall be assembled in a UL 508 certified facility. A submittal of documentation certifying that the panel fabrication facility is a UL 508 certified facility is

required.

- C. The control panel shall meet all applicable requirements of the National Electrical Code
- D. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Completed industrial control panels and related equipment shall be handled and stored in accordance with manufacturer's instructions.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped with each panel.

#### 1.7 SITE CONDITIONS - NOT USED

#### 1.8 WARRANTY

- A. Extended Equipment Warranty: Refer to Section 01 78 36 - Warranties for extended equipment warranty.
- B. All equipment furnished under this section shall have a special equipment warranty, in accordance with the Contract Documents, for a period of 2 years after the date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 RATINGS

- A. Short circuit withstand and interrupting rating greater than upstream feeder device, but less than 22,000 Amps rms symmetrical at 480/277 VAC
- B. Selective device coordination between the Main Breaker, Feeder Breakers and control circuit protective devices.
- C. The manufacturer shall produce and install on each panel, an Arc Flash Warning Label listing the various Flash Hazard Protection Boundaries, calculated from NFPA 70E, Annexes, as listed below:
  - 1. Flash Hazard Protection Boundary.
  - 2. Limited Approach Boundary.
  - 3. Restricted Boundary.
  - 4. Prohibited Boundary.
  - 5. Incident Energy Level.
  - 6. Required Personal Protective Equipment Class.
  - 7. Type of Fire Rated Clothing.
- D. Provide an Arc Flash Warning Label, printed in color and affixed to the front of each panel provided. Size of each label shall be not less than 8 inches wide and 6 inches tall.

#### 2.2 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that

may be incorporated into the Work include, but are not limited to, have been named within the various paragraphs of this Section.

## 2.3 GENERAL REQUIREMENTS

- A. Device mounting to provide ease of maintenance and adjustment.
- B. Components shall be mounted in a manner that shall permit servicing.
- C. Components mounted on removable plates.
- D. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc.
- E. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking.
- F. Nameplates
  - 1. All panels and panel devices shall be supplied with suitable nameplates which identify the panel and individual devices as required.
  - 2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32-inch thick, black and white, Lamicaid with engraved inscriptions.
  - 3. The letters shall be Black against a White background unless otherwise noted. Edges of the nameplates shall be beveled and smooth.
  - 4. Nameplate fasteners and mounting shall be epoxy adhesive or stainless-steel screws for cabinet mounted nameplates
  - 5. For every panel, provide an overall panel nameplate with a minimum of 1-inch high letters.

## 2.4 PANEL REQUIREMENTS

- A. Freestanding and Floor-Mounted Vertical Panels
  - 1. Meeting NEMA classification as shown on the drawings or specified herein.
  - 2. Constructed of 12-gauge sheet steel
  - 3. Suitably braced internally for structural rigidity and strength.
  - 4. NEMA 4X rated panels shall be constructed of type 304 stainless
  - 5. Furnished with print storage pockets on left door
  - 6. Furnished with folding shelf on the right-hand door
- B. Wall and Channel Mounted Panels
  - 1. Meeting NEMA classification as shown on the drawings or specified herein
  - 2. Constructed of not less than 14-gauge steel
  - 3. Suitably braced internally for structural rigidity and strength.
  - 4. NEMA 4X rated wall mounted panels shall be constructed of type 304 stainless steel
- C. Structure and Enclosure Requirements
  - 1. Panels shall be of continuous welded-steel construction
  - 2. Provide angle stiffeners as required on the back of the panel face to prevent panel



3. Provide removable lifting rings
4. Each panel shall be provided with full height, fully gasketed access doors
5. Doors shall be provided with a three-point stainless steel latch and heavy-duty stainless-steel locking handle
6. Panel doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins.
7. The panel shall be suitable for top and bottom conduit entry
8. All panels in indoor, environmental controlled environments (air conditioned) shall be NEMA
9. All panels installed indoors, in non-environmental controlled environments or panels installed in outdoors shall be NEMA 4X
10. All panels located in a hazardous location shall be rated for the type of hazard

D. Finish Requirements

1. Enclosure when fabricated of steel shall be finished with 2 rust resistant phosphate prime coats and 2 coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum panels will not require a paint finish.
2. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.
3. Immediately after cleaning, 1 coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and topcoat of a 2-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.
4. Apply a minimum of 2 coats of manufacturer's standard, flat light-colored lacquer, on the panel interior after priming.
5. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish.

## 2.5 ENVIRONMENTAL CONDITIONING

A. Condensation Control

1. Provide condensation heater with thermostat and fan
  - a. Enclosure heaters shall be energized from 120 V.
  - b. Locate enclosure heaters to avoid overheating electronic
  - c. Provide internal fan for heat distribution, with adjustable thermostat
  - d. Enclosure heaters shall be Hoffman type DAH or equal.
2. Provide strip heaters (where shown on drawings)
  - a. Strip shall be as manufactured by Chromalox or equal.
  - b. Provide with control thermostat, Chromalox, Type WR or equal
  - c. The strip heater terminals shall be guarded by a protective terminal cover.
  - d. High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox,

Catalog No. 6-CFI-12, Product Code No. 263783, or equal.

3. Each panel shall have a 1/2-inch stainless steel condensate drain installed on a stainless-steel conduit hub, HGTZ Series, T&B or equal, in the bottom of the enclosure. Drain shall be O-Z Gedney DBB-50SS, or equal.

B. Ambient Control

1. Provide ambient temperature control within the
2. Provide panel internal heat rise calculations
3. The air conditioner shall have the following features:
  - a. Provide CFC-free R134a refrigerant.
  - b. Separated blower-driven evaporator and condenser air systems for closed loop cooling.
  - c. Stainless steel enclosure.
  - d. The air conditioning unit shall be Hoffman, Thermo Electric or approved equal.

2.6 CORROSION CONTROL

A. Panels shall be protected from internal corrosion

1. Provide corrosion-inhibiting vapor capsules
2. Manufactured by:
  - a. Northern Technologies International Corporation, Model Zerust VC
  - b. Hoffman Model AHCI
  - c. or equal.

2.7 INTERNAL POWER DEVICES

A. Main Circuit Protective Device

1. Molded case (MCCB), 3-Pole, 600 V, fixed type, manually operated with stored energy closing mechanism.
2. Trip device shall be solid state with adjustable long time pickup and delay
3. Where indicated, Provide a flange mounted main power disconnect

2.8 NETWORK DEVICES

A. Fiber Optic Patch Panel

1. Provide DIN rail mounted patch panels.

B. CAT 6 Patch Panel

1. Provide DIN rail mounted patch panels

2.9 PANEL MOUNTED HMI/PLC PUMP CONTROLLERS (UPCS)

- A. Panel door mounted HMI & PLC controller
- B. 12-inch diagonal (nominal) touch screen display with 800x600 pixel resolution.
- C. Micro SD card for datalogging
- D. Communication Ports:
  1. Ethernet (configured as Modbus Slave)

2. Mini USB
  3. Serial - (2) RS232/RS485
- E. Input/Output Devices:
1. (18) 24 VDC digital inputs
  2. (17) 5A relay contact outputs rated for up to 230 VAC
  3. (4) 4-20 mA inputs
  4. (4) 4-20 mA analog outputs
- F. Pre-assigned I/O for controller in the specified application.
- G. Simplex, duplex, triplex or quadraplex (1 to 4 pump) operation
- H. Compatible with constant speed (FVNR), reduced voltage (RVSS) or variable speed (VFD) motor starters
- I. Configurable to communicate with VFDs, RVSSs, and "Smart Starters" using Modbus TCP
- J. Controller Modes:
1. Level Mode: In level control mode, the UPC shall support the connection of two complete level sensing systems, along with redundant high and low level floats.
- K. UPC furnished with preconfigured screens:
1. Main Dashboard
  2. Pump Dashboard
  3. SOFT HOA switches
  4. Status Indicators
  5. Run Hour Meters
  6. Pump Starts counter
  7. Pump Alternation
  8. Set Points
  9. Alarm Monitoring
  10. Flow meter and calculated flow total
- L. Provided with complete Memory Map.
- M. Provide any expansion modules for complete monitoring and alarming of all points identified in Section 40 61 93 and on the Contract Drawings.
- N. Manufacturer:
1. PUMP Vision PV1200, as manufactured by CMC.

## 2.10 CABLES & CONVERTERS

- A. Provide two programming cables for each type of PLC to be programmed.
- B. Ethernet Protocol Converter
1. Manufacturers:
    - a. Digi
    - b. B&B Electronics

- 2. Environmental
  - a. Operating temperature: 32-140 degrees F
  - b. Operating humidity: 10–90 percent Non-condensing
- C. Physical
  - 1. Power Supply: 24 VDC
  - 2. DIN Rail mountable.
  - 3. Class 1 Division 2 rated
- D. Functional Performance
  - 1. 10/100 BaseT ports with RJ-45 connectors for Category 6 cabling.
  - 2. ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber
  - 3. RS 232 Ports with terminals

#### 2.11 INDUSTRIAL ETHERNET MEDIA CONVERTER

- A. Manufacturers:
  - 1. Beldon
  - 2. B & B Electronics
  - 3. Moxa
  - 4. N-TRON
  - 5. SIXNET
- B. Environmental
  - 1. Operating temperature: 32-104 degrees F
  - 2. Operating humidity: 20–95 percent Non-condensing
- C. Physical
  - 1. Power Supply: 24 Vdc
  - 2. Microprocessor based managed type.
  - 3. DIN Rail mountable.
- D. Functional Performance
  - 1. ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber

#### 2.12 FACTORY TESTING

- A. Completely assembled, wired, and adjusted at the factory
- B. Operational test shall include the proper connection of supply and control voltage

#### 2.13 EXTRA MATERIALS/SPARE PARTS

- A. Furnish extra materials matching products installed
- B. As indicted in the table below:

Description	Percent of Each Type and Size Used	No Less Than
Dc power supplies	20	2
Fuses	20	10
Relays and bases	20	10
Analog surge protectors	20	3
Power line surge protectors	20	2

### PART 3 - EXECUTION

#### 3.1 INSTALLER'S QUALIFICATIONS

- A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

#### 3.2 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the equipment.
- B. Housekeeping pads shall be included for the floor mounted panels as detailed on the drawings.
- C. Check concrete pads and baseplates for uniformity and level surface.
- D. Verify that the equipment is ready to install.
- E. Verify field measurements are as instructed by manufacturer.

#### 3.3 INSTALLATION

- A. Installed per the manufacturer's recommendations
- B. Install required safety labels.

#### 3.4 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.
- C. Provide laminated copies of the control schematics along with the final approved I/O list in each enclosure door pocket.

#### 3.5 CLEANING

- A. Remove all rubbish and debris from inside and around the panel.

#### 3.6 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces

#### 3.7 TESTING, COMMISSIONING AND TRAINING

- A. Testing and Commissioning: Accomplished in accordance with the requirements of Section 01 70 00 - Execution and Closeout Requirements.
- B. Training: Accomplished in accordance with the requirements of Section 01 70 00 - Execution and Closeout Requirements.

**END OF SECTION**

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**SECTION 40 12 16.40**  
**MISCELLANEOUS VALVES AND APPURTENANCES**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnishing and installation of miscellaneous valves, cocks and stops for station service including operators, valve boxes and accessories as shown on the Plans and specifications.

**1.2 SUMMARY**

- A. This Section includes the following general-duty valves:
  - 1. Ball Valves, Stainless Steel, 12-inches and smaller.
  - 2. Plug Valves, Ductile Iron, 3-inches and larger.
  - 3. AWWA Swing Check Valves
  - 4. Backflow Preventer, Reduce Pressure.
- B. Related Sections:
  - 1. Section 01 33 00 – Submittals
  - 2. Section 01 75 25 – Equipment Testing and Startup
  - 3. Section 01 78 23 – Operations and Maintenance Data
  - 4. Section 40 05 78.13 – Air Release and Air/Vacuum Valves
    - a. For air release valves and combination air/vacuum release valves for water and sewerage service.

**1.3 QUALITY ASSURANCE**

- A. Referenced Standards: As specified for individual valves in Part 2.
- B. Each valve shall have manufacturer's nameplate in stainless steel showing the pressure ratings, serial and model numbers, year manufactured and other pertinent data.
- C. Valve supplier shall maintain a complete stock of spare parts in the State of Oklahoma or shall indicate that parts will be delivered upon 48 hours of receipt of request.
- D. Obtain all valves of the same style and type, along with the associated manual operators, from a single manufacturer.
- E. NSF Compliance: NSF 61, "Drinking Water Systems Components – Health Effects" for valve materials for potable-water service.
- F. Valve manufacturer shall demonstrate a minimum of five years of experience in similar applications for size of valves furnished. References shall be provided upon request.
- G. Provide Manufacturer's standard warranty for all products listed.

**1.4 SUBMITTALS**

- A. Shop Drawings and Product Data:
  - 1. Comply with the general requirements of Section 01 33 00 and the supplemental requirements below.
  - 2. Submit one drawing or illustration showing unit construction for each type and size valve used.

3. Submit the following information for each type of valve furnished:
    - a. Specific application in terms of service and contract drawing number where shown.
    - b. Description including type of valve, type of operator and accessories included.
    - c. Size and type of end connections.
    - d. Maximum non-shock working pressure for which valve is designed.
    - e. Materials of construction and coatings for valves and accessories.
    - f. Manufacturers make and model.
  4. If catalog bulletins are used to communicate above information, mark out inapplicable information.
- B. Affidavits:
1. Submit affidavits of compliance with the reference standards when standards are specified.
- C. Operation and Maintenance Data:
1. Comply with the requirements of Section 01 75 25, 01 78 23, and 01 33 10.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of the General Conditions and manufacturers' recommendations.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Obtain all valves, extensions, and associated manual operators of a given type from a single manufacturer.
- B. Furnish valves in the sizes specified on the Drawings.
- C. Valves shall be capable of withstanding the maximum system pressures.
- D. Valve operators to turn to left, counterclockwise, to open and to right, clockwise, to close.
- E. End connections shall be compatible with those specified for pipe.
- F. Paint valves and operators as shown on the plans and specified in Section 09 91 00, Painting, colors to be selected by OWNER.
- G. All hardware shall be 316 stainless steel.
- H. Contractor shall provide insulation kits where necessary for dissimilar metals.

#### 2.2 BALL VALVE

- A. Stainless Steel Ball Valve, ½-inch to 2-inches:
  1. Three-piece body, full port, vented ball, block-out proof stem, Type 316 stainless steel trim, reinforced TFE seat and seal, threaded ends, lever operator, rated 1000-psi CWP. Conforms to MSS SP-110.
  2. End Connection shall be as noted on the plans
  3. Manufactures:
    - a. Contromatics.



- b. Crane Valve Group
  - c. NIBCO
- B. Stainless Steel Ball Valve, 2-inches to 12-inches:
  - 1. Unibody design, blowout-proof stem, Type 316 stainless steel trim, mounting pad, fire safe, vented ball, flanged ends, rated 275-psi CWP. Conforms to MSS SP-72 and MSS SP-25.
  - 2. Manufactures:
    - a. NIBCO

### 2.3 PLUG VALVE

- A. Valve type: Eccentric Plug non-lubricated, resilient seated with port area not less than 100 percent of pipe area.
- B. Nonshock working pressure at 100°F:
  - 1. 175 psig, 1-inch to 12-inch.
  - 2. 150 psig, 14-inch to 36-inch.
- C. Valve Construction:
  - 1. Body: Cast iron.
  - 2. Plug: Ductile iron, Buna faced.
  - 3. Bearings: Oil impregnated stainless steel and teflon.
  - 4. Shaft seal: Nitrile butadiene chevron packing, bronze cartridge with O-rings or V-type.
  - 5. Body seat: Nickel steel machined.
  - 6. Furnish grit seats in upper and lower journals.
  - 7. Interior coating: 4 - 6 mil of 2-part hi-build epoxy.
  - 8. Exterior Coating: Epoxy coating in accordance with AWWA C550.
  - 9. End Connections: Flanged for lift station discharge piping
- D. Manufacturers:
  - 1. DeZurik
  - 2. Valmatic
  - 3. Keystone

### 2.4 AWWA SWING CHECK VALVES

- A. AWWA Swing Check Valve, 2-inches through 30-inches Rubber Seated Swing Check Valve
  - 1. Referenced Standard: AWWA C508.
  - 2. Non-shock working pressure at 100 °F: 150, unless shown otherwise on the Plans.
  - 3. End connections: Flanged.
  - 4. Body: Full ported ductile iron (ASTM A126-B).
  - 5. Cover: Bolted, ductile iron (ASTM A126-B).
  - 6. Disc: Ductile iron (ASTM A126-B).
  - 7. Seat Ring: Rubber.
  - 8. Shaft: Stainless steel, Type 18-8.
  - 9. Body seat: Stainless steel, Type 316.

10. Cover bolts and trim to be stainless steel, Type 316.
  11. Stuffing box: Composition packing.
  12. Interior coating: Two part hi-build epoxy.
  13. Exterior Coating: Epoxy coating in accordance with AWWA C550.
  14. Operator: Adjustable lever arm with weight and hydraulic cushion dashpot with adjustable closing speed. Hydraulic cushion dashpot shall be side mounted.
  15. Valves in exposed exterior applications and where indicated to be insulated shall have extended shaft to allow for valve insulation.
- B. Acceptable manufacturers:
1. GA Industries, Swing Check Valve
  2. DeZurik/APCO Series 6000.
  3. Equal by Crispin Valve.

## 2.5 MISCELLANEOUS VALVES AND RELATED ITEMS

- A. Reduced Pressure Backflow Preventer:
1. Description: Two check valves, independent relief between the valves; NRS isolation gate valves or ball valves, testing cock in accordance with AWWA C511, rated 175-psi CWP, meet requirements of USC Cross connection Control Laboratory.
  2. Manufacturers:
    - a. Cla-Val Company, Model RP Series
    - b. FEBCO; Model 825Y, 825YD.
    - c. Watts 909

## 2.6 ACCESSORIES

- A. Furnish accessories specified in valve specifications and as required for a complete system.
- B. Floor boxes to have cast iron bodies and bronze bushings.
- C. Valve boxes for buried service:
1. Three-piece screw type 5-1/2-inch diameter, cast iron construction.
  2. Concrete pad 2'-0" diameter x 6" thick around valve box at ground surface.
  3. Other features as shown on drawings.
- D. Stem guides to be made of cast iron with bronze bushings and to have adjustable offset.
- E. All components of shaft extensions shall be stainless steel including nut shaft, shaft housing and guides. Minimum shaft diameter shall be 1-inch or diameter of valve shaft, whichever is larger. All components shall have continuous welded joints. Provide stem guides or rock shields at 5-foot intervals.
- F. Valve Operator:
1. Handwheel: For valves other than quarter-turn types.
  2. Lever Handle: For quarter-turn valves 6-inch and smaller.
- G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.
- H. Threaded: With threads according to ASME B1.20.1.

- I. Manufacturers:
  - 1. Floor boxes: Clow, Model F-5695.
  - 2. Valve boxes for buried service: Clow, Model F-2454.
  - 3. Stem guides: Trumbull, Model 367 .
  - 4. Chain wheels: Clow, Model F-5680.
  - 5. Floor stands: Clow, Model F-5515.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all valves, floorstands, and appurtenances in complete accordance with manufacturer's instructions and recommendations.
- B. Installation shall be in accordance with the plans, approved shop drawings and the manufacturer's instructions.
- C. Install valves and valve operators to provide for ease of access and operation.

3.2 FIELD QUALITY CONTROL

- A. Retain a qualified representative of the manufacturer to perform the following services:
  - 1. Inspect the completed installation and note deficiencies.
  - 2. Assist the CONTRACTOR during start-up, adjusting, and site testing of completed installation as required.
  - 3. Instruct OWNER personnel in the operations and maintenance of the equipment.

3.3 FIELD TESTING:

- A. Testing and startup will be in accordance with Section 01 75 25.

**END OF SECTION**

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**SECTION 40 61 00**  
**INSTRUMENTATION AND CONTROL SYSTEM GENERAL PROVISIONS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The CONTRACTOR shall procure the services of a Control System Integrator to furnish and install all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein, in the Specification Sections listed below, and in related drawings, except for those services and materials specifically noted;
  - 1. Section 40 05 92 - Common Control Panel Requirements For Pumping Systems
  - 2. Section 40 61 01 - Instrumentation and Control System Abbreviations
  - 3. Section 40 61 21 - Instrumentation and Control System Testing and Commissioning
  - 4. Section 40 61 26 - Instrumentation and Control System Training
  - 5. Section 40 61 96 - Control System Configuration
  - 6. Section 40 61 93 - Control System Input/Output List
- B. The term "Control System Integrator" as used in the Contract Documents is a firm or organization that has specialized capabilities, training and education to design, fabricated, install, and program a control system. The term as used in documents shall be performed by the Control System Integrator under the direction and authority of the CONTRACTOR. When used within the Contract Documents, it implies that the CONTRACTOR has directed or is responsible for their actions regarding the Contract Documents and responsibility to the OWNER. The Control System Integrator can act as the CONTRACTOR, but shall comply with the qualifications listed in this Section and shall meet all other requirements of the Contract Documents."
- C. Universal Pump Controller that is a combination Programmable Controller and Human-Machine Interface (HMI) shall be configured as required in Section 40 05 92 and 40 61 96.
- D. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.
- E. All equipment and installations shall satisfy applicable Federal, State, and local codes.
- F. Use the equipment, instrument, and loop numbering scheme shown on the Drawings and Specifications in the development of the submittals. Do not deviate from or modify the numbering scheme without the ENGINEER's approval.
- G. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the

listed standards, the requirements of this Section shall prevail.

- B. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Control System Integrator unless otherwise directed by the OWNER/ENGINEER.
- E. In accordance with the intent of the Contract Documents, the Control System Integrator accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Control System Integrator's responsibility to comply with all Laws and Regulations at all times
- F. All control panels shall be constructed and the labeled with a UL 508A label.

### 1.3 ADMINISTRATIVE REQUIREMENTS (NOT USED)

### 1.4 SUBMITTALS

- A. General Requirements:
  - 1. Submittals shall be made in accordance with the requirements of this Section, the requirements of individual Division 40 Sections, and in accordance with Section 01 31 00 - Project Management and Coordination.
  - 2. Exceptions to the Specifications or Drawings shall be clearly defined in a Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for the exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the ENGINEER. If no exceptions are taken to the specifications or drawings, the Control System Integrator shall make a statement as such. If there is no statement by the Control System Integrator, then it is acknowledged that no exceptions are taken.
  - 3. Project schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. Control System Integrator schedule must be based on the General CONTRACTOR schedule and must meet all field installation, testing, and start-up milestones in that schedule. The project schedule shall illustrate instrumentation and control related major project milestones including the following:
    - a. Schedule for all subsequent project submittals. Include the time required for CONTRACTOR submittal preparation, ENGINEER's review time, and a minimum of two complete review cycles.
    - b. Proposed dates for all project coordination meetings.

- c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
  - d. Software purchasing and configuration (following approval of related submittals).
  - e. Shipment of instrument and control system equipment.
  - f. Installation of instrument and control system equipment.
  - g. Testing: Schedule for all testing.
  - h. Schedule for system cutover, startup, and going on-line for each major system. At a minimum include the schedule for each process controller.
  - i. Schedule for all training, including submittal and approval of O&M manuals, factory training, and site training.
  - j. Incorporate time constraints for control system configuration activities as outlined in Section 40 61 96 - Control System Configuration.
4. All Control System Panel shall have a UL 508A label affix to the inside of the panel. Provide documentation for review and approval on how this will be accomplished by control system integrators who are not a UL 508 facility.
- B. Field Instruments Submittal
- 1. Shall be a mode in accordance with the general requirements of Section 01 31 00 - Project Management and Coordination and with specific submittal requirements of Section 40 70 00 - Instrumentation Measurement Devices.
- C. Hardware and Software Packages Submittal
- 1. Refer to the sections below for specific Hardware and Software Packages submittal requirements
    - a. Section 40 05 92 - Common Control Panel Requirements for Pumping Systems
    - b. Section 40 63 93 - Cellular-Web Based Monitoring System
  - 2. For each hardware and software packages component specified in the sections above, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, Location(s), and power required. The preferred format for the cover page is ISA-TR20.00.01-2001 (updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all required information.
- D. Control System Panel Drawings Submittal
- 1. Shall be a mode in accordance with the general requirements of Section 01 31 00 Project Management and Coordination and with specific submittal requirements of Section 40 67 00 - Control System Panels.
- E. Testing and Commissioning Submittals
- 1. Shall be made in accordance with the general requirements of Section 01 70 00 - Execution Requirements and with specific submittal requirements of Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
- F. Training Plan Submittals
- 1. Shall be made in accordance with the general requirements of Section 01 70 00 - Execution Requirements and with specific submittal requirements of Section 40 61 26

- Instrumentation and Control System Training.

G. Control System Configuration

1. Shall be a mode in accordance with the general requirements of Section 01 31 00 - Project Management and Coordination and with specific submittal requirements of Section 40 61 96 - Control System Configuration.

H. Spares, Expendables, and Test Equipment Lists Submittal

1. Submit a list of, and descriptive literature for, spares, expendables, and test equipment.
2. Submit a list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer.
3. Submit unit and total costs for the additional spare items specified or recommended for each subsystem.

I. Operations and Maintenance (O&M) Manuals

1. Shall be made in accordance with the requirements of this Section, the requirements of individual Division 40 Sections, and in accordance with Section 01 31 00 - Project Management and Coordination.
2. The operations and maintenance manuals shall, at a minimum, contain the following information:
  - a. Table of Contents
    - 1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
  - b. Instrument and Equipment Lists
    - 1) The following lists shall be developed in Microsoft Excel format and provided not only as a hardcopy in O&M but also electronically on a CD.
    - 2) An instrument list for all devices supplied including tag number, description, specification section, and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
    - 3) An equipment list for all non-instrument devices supplied a listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
  - c. Equipment Operations and Maintenance Information
    - 1) ISA-TR20.00.01-2001 (updated in 2004-2006) data sheets shall be provided for all field instruments. For non-field instrumentation devices, provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number, Location(s), and power required. The preferred format for the cover page is ISA-TR20.00.01-2001 (updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all



required information

- 2) Vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.
  - 3) Provide the record documentation of the system testing as specified in Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
  - 4) Include the calibration forms developed as specified in Section 40 70 00 - Instrumentation Measuring Devices.
- d. As-Built Drawings
- 1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the Control System Integrator.
  - 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and Functional Acceptance Tests shall be incorporated in this documentation.
- e. Original Licensed Software
- 1) Submit original software diskettes or CD-ROMs of all software provided under this Contract. Submit an original paper-based and electronic documentation for all software provided. Submit license agreement information, including serial numbers, license agreements, User Registration Numbers, and related information. All software provided under this Contract shall be licensed to the Owner at the time of purchase. Provide media in software sleeves within O&M manual.
- f. Electronic O&M Information
- 1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on CDROM or DVD. Electronic documents shall be supplied in Adobe Acrobat format.
  - 2) Provide electronic files for all custom-developed manuals, including training manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
  - 3) Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen and line styles, fonts, and the drawing file into individual zip files.
  - 4) Each computer system hardware device shall be backed up onto CDROM or DVD after Substantial Completion and shall be turned over to the Owner.

- 5) If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 800 by 600 pixels and shall include sound.
- g. System Maintenance Manuals:
- 1) The manual shall be detailed to the component level, including assemblies, subassemblies, and other related components. It shall contain a detailed analysis of each major component so that maintenance personnel can effectively service, inspect, maintain, adjust, troubleshoot, and repair the equipment. Each manual shall include a Table of Contents, arranged in systematic order, and divided into separate sections.
  - 2) The manual shall also include all applicable visual examinations, hardware testing, diagnostic hardware/software routines. Instruction on how to load and use any test and diagnostic programs and any special or standard test equipment shall be included.
3. The cover and edge of each volume shall contain the information as specified in Section 01 31 00 - Project Management and Coordination.

## 1.5 QUALITY ASSURANCE

- A. The Control System Integrator shall be a "Systems Integrator" regularly engaged in the design, installation, and maintenance of instrumentation and control systems specifically for the Water and Wastewater industry. Subject organizations shall meet or exceed all of the following requirements:
1. Have been in business under the same ownership/management for a minimum of 5 years.
  2. Have successfully completed at least ten projects of similar size and complexity in the last five most recent years.
  3. Employ at least one full time licensed Professional Engineer (P.E.) who shall supervise all software development and programming related to this project. Submittals related to Section 40 61 96 - Control System Configuration shall bear required seal and signature.
  4. Employ an adequate number of full-time degreed engineers and technicians who have a minimum of 10 years' experience working on projects and systems of similar size and complexity.
  5. Have and maintain an ISA accredited certification program for all employed technicians and installers.
  6. Have and maintain a stand-alone "Service Department" with a proven history of actively pursuing and executing on-going maintenance service contracts, including emergency services 24 hours 7 days a week.
  7. Have and maintain a fully staffed Industrial Network department capable of performing and supporting IT and related networking or communications project requirements.
  8. Have and maintain environmentally controlled space dedicated to the production, assembly, check-out, and testing of custom control panels. The organization must be a certified UL-508 panel facility or shall demonstrate how panels will obtain UL-508A

labels in the project plan.

9. Shall be a certified solution provider or value-added re-seller where the manufacturer provides certification for the major control components; Programmable Logic Controllers or Human Machine Interfaces for those products used on the project.
- B. The Control System Integrator shall be selected by the CONTRACTOR and approved by the ENGINEER and OWNER.
- C. Installer Qualifications: manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- D. Source Limitations: Provide equipment that is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.
- E. Calibration Instruments: Each instrument used for calibrating control system equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology.
- F. 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. Deliver, handle, and store control system components in accordance with manufacturer's written instructions and the requirements of Section 01 60 00 - Product Requirements.
- B. The specific requirement for the control system:
- C. Provide site and warehouse storage facilities for control system equipment.
- D. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.
- E. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- F. Cover panels and other elements that are exposed to dusty construction environments.
- G. Computer and network equipment shall not be placed into service until the room or building is fully enclosed and has functional HVAC equipment.

#### 1.7 SITE CONDITIONS

- A. Operating Conditions:
  1. Ambient Conditions: Provide equipment suitable for ambient conditions in accordance with environment requirement paragraphs specified below.
  2. Field Locations: Field equipment may be subjected to ambient temperatures from 0-120° F, with direct radiation, and relative humidity from 45 to 96% with condensation. Field equipment will also experience rain, freezing rain, and snow.
  3. Power Supply: Power supply will be 120 Vac, single-phase, 60 Hz commercial power. Voltage variations will be at least plus or minus 8%. Certain loops shall have integral power supply as indicated on the drawings.

- B. Standard Environment Requirements: Unless otherwise noted, design equipment for continuous operation in these environments.
  - 1. Inside, dry and environmental controlled environments (Heat, Ventilated, and air-conditioned: NEMA 4.
  - 2. Inside, wet and damp locations or those in chemical areas: NEMA 4X.
  - 3. Outside: NEMA 4X

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the control system that fail(s) in materials or workmanship within the specified warranty period.
  - 1. Warranty Period: Two (2) years from the date of completion of the Site Acceptance Test.
  - 2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty, as well as replacement of defective work.
- B. Corrective Maintenance
  - 1. Services: Provide services of factory-trained service technicians for performing corrective maintenance on all system hardware and software for maintenance on the control system.
    - a. Provide a 24-hour, 7 day-a-week service hotline for telephone notification of system malfunctions.
    - b. Within 2 hours from notification by the OWNER of defective control system operation, a qualified service representative will establish telephone contact with the OWNER'S maintenance personnel to discuss short-term corrective measures.
    - c. If it is not possible to correct the defective operation as a result of the telephone contact, provide a qualified service representative at the location of the installed control system within 24 hours from initial notification.
    - d. Service representative shall perform all necessary inspections and diagnostic tests to determine the source of the defect and to establish a corrective action plan. The corrective action plan shall be developed such that the defect is corrected as quickly as possible and with the least impact on the operation of the OWNER's facilities.
    - e. Prior to beginning any repair or replacement procedure, review the corrective action plan with the OWNER informing of the planned course of action and to allow assessment of any impact it might have on the operation of the OWNER's facilities.
    - f. Replacement or repair of the defective component will be accomplished using replacement parts from the spare parts inventory delivered with the system. If not, the corrective action plan shall include a detailed schedule for the planned course of action.
    - g. Once the defect has been corrected, the corrective action plan shall be updated indicating the source of the defect and specific corrective action taken. A copy

- of the updated corrective action plan shall be delivered to the OWNER on the day the work is performed.
- h. Any spares from the onsite supply of spares used in correcting the system malfunction shall be replaced within 15 days.
  - i. At OWNER'S option, OWNER maintenance personnel may participate in any corrective maintenance procedures.
2. If 24-hour response time is not provided, or other corrective maintenance requirements are not met, the OWNER shall have the right to obtain corrective maintenance from other sources and charge the Control System Integrator reasonable costs of the alternative maintenance services, including parts, labor, travel, and subsistence.
- C. The OWNER, at Owner's option, may elect to employ its own maintenance staff to locate and remove a defective component. In this case, the OWNER will return the defective component to a repair location as instructed by the Control System Integrator. The Control System Integrator shall repair or replace the defective component and return the properly working unit to the OWNER within 15 days.

#### 1.9 MAINTENANCE CONTRACT

1. A written proposal for a maintenance contract executed by the Control System Integrator shall be provided to the Owner for on-site preventive maintenance services related to the Instrumentation and Control System. The cost of this maintenance contract shall not be included in the Contract Price.
2. This proposal shall be provided within 30 days after final acceptance for the purpose of entering a contract for annual maintenance subsequent to the first year of maintenance. Standard per diem rates for providing breakdown service shall be outlined in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from date of issue.
3. This maintenance contract shall include all labor, parts, and emergency calls providing an on-site response within 24 hours, to provide complete system maintenance for a period of one year after the date of Substantial Completion of the system for all equipment and software provided as part of the Control System Integrator's scope of work.
4. Provide software updates throughout the maintenance contract period. Provide the latest officially released version for all software provided under this Contract. The OWNER shall have the latest software releases at the end of the maintenance contract period.
5. The maintenance contract shall also include a minimum of 4 preventive maintenance visits by qualified service personnel of the Supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and verification of correct operation.
6. Visits to the sites to correct deficiencies under warranty shall not be included in this preventive maintenance service contract.
7. Emergency maintenance procedures or plant visits may coincide with a preventive

maintenance visit. However, they shall not replace the work intended to be performed during a preventive maintenance visit. The Supplier shall have full responsibility for the system hardware preventive and corrective maintenance.

8. During the one-year maintenance period, observation of maintenance operations by plant personnel, and the instruction of said personnel in the details of the maintenance work being performed shall be provided.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Control system functions as shown on Drawings and as required for each loop. Furnished equipment items and devices as required. Furnish all materials, equipment, and software required to affect the required system and loop performance.
- B. Manufacturers: Subject to compliance with requirements, control system design is based on the named manufacturers of equipment and materials.
  1. If an item is proposed other than the named manufacturer, obtain approval from the ENGINEER for such changes in accordance with Section 01 31 00 - Project Management and Coordination.
  2. If the proposed item requires, i.e., different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, furnish equipment, and work.
- C. Like Equipment Items:
  1. Use products of one manufacturer and the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
  2. Implement all the same or similar functions in the same or similar manner — for example, control logic, the sequence of controls, and display layouts.
- D. Special Project Coordination Requirements: As a part of this contract, the instrumentation systems CONTRACTOR shall coordinate with all the sub-systems suppliers and manufacturers, during bidding, construction, testing, installation and start-up phases of the project. The coordination is to assure that the instruments and sub-systems are in compliance with the specifications and the central controls and that the tie-ins and the interface signals are provided as required.

### 2.2 INFORMATION ON DRAWINGS

- A. The following information is indicated in the drawings:
  1. Loop diagram on flow sheet for each control loop. Diagrams are schematic in nature and intended only as a guide to working to be performed.
  2. Approximate location of primary elements, instrument panels, and final control elements.
  3. Approximate location of instrumentation power junction boxes for instrument electrical power connection.
  4. Location of electrical distribution panel boards for instrument electrical power.
  5. Location of equipment having alarms and equipment status contacts.
  6. Location of equipment being controlled by the system.

7. The general layout of instrument cabinets.
  8. Instrument installation details.
- B. The following information is not shown on drawings but shall be the responsibility of the CONTRACTOR to determine, furnish, and coordinate with other divisions, based upon systems specified. Show this information on project record drawings.
1. Instrument Loop Drawings per ISA S5.4 minimum, desired, and optional items.
  2. Location of electrical distribution panel boards supplying power to any device supplied under this contract.
  3. Detailed enclosure and instrument panel layouts, fabrication details and wiring diagrams.
  4. Detailed system configuration.
  5. Raceway and cable routing for instrumentation wiring.
- C. Instrument Tag Numbers: A shorthand tag numbers are used in the Contract Documents.

### 2.3 CONTROL SYSTEM CONTROL NARRATIVES

- A. Refer to Section 40 61 96 - Control System Configuration for a description of control loops for the control system.
- B. Functional Requirements for Control Loops:
1. Shown on Drawings, in Panel Control Diagrams and Process and Instrumentation Diagrams (P&ID).

### 2.4 INSTRUMENT AND CONTROL COMPONENTS

- A. Major components for each instrument are listed in the Instrument Data Sheets referenced in Section 40 70 00 - Instrumentation Measurement Devices.
1. Comply with the various component specifications located in Division 40 Sections, as well as in applicable Division 26 Sections.
  2. Component General Requirements:
    - a. Provide equipment of solid-state construction utilizing second source semiconductors, unless otherwise specified. De-rate components to assure dependability and long-term stability.
    - b. Provide printed or etched circuit boards of glass epoxy, hand or wave soldered, of sufficient thickness to prevent warping. Coat printed circuit boards in field-mounted equipment with Plasite 7122, or approved equal, to protect against corrosion.
    - c. Alignment and adjustments shall be non-critical, stable with temperature changes or aging, and accomplished with premium grade potentiometers. Do not insert components of specially selected values into standard electronic assemblies to meet performance requirements.
    - d. Use parts indicated in instruction manuals, replaceable with standard commercial components of the same description without degrading the performance of the completed assembly. Do not use silver edge connectors or pins.
- B. Test Equipment: Use test equipment and instruments to simulate inputs and read outputs

suitable for the purpose intended and rated to an accuracy of at least 5 times greater than the required accuracy of the device being calibrated. Such test equipment shall have accuracies traceable to the National Bureau of Standards as applicable.

- C. Components, Hazardous Area Location:
  - 1. Assure equipment located in hazardous areas is suitable for applicable classification by use of explosion-proof housings or equipment and barriers approved as "intrinsically safe" by either UL or FM.
  - 2. Locate barriers in cabinets at hazardous area boundaries. Use dual barriers in loops in order to prevent grounding loop at the barrier.

## 2.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Spare Parts:
  - 1. During the system warranty period, the Control System Integrator shall provide system repairs by initially replacing the defective component with one from the spares inventory.
  - 2. The Control System Integrator shall then replace the spare component. Rather than place the new component in the spares inventory, the Control System Integrator shall replace the spare that had been installed in the system during the initial repair. This procedure shall ensure that all new components provided as spares are fully tested and compatible with the installed system.
  - 3. Spare requirements as specified in other Division 40 sections.
- C. Special Tools: One of each type of special hand tool required to open or operate equipment, to remove or replace replaceable parts, remove or replace cable connectors, or to make required operational or maintenance adjustments. A special hand tool is any tool not readily available from local retail hardware stores.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with manufacturer instructions. The indicated locations of equipment, transmitters, alarms, and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the ENGINEER during construction. Obtain in the field, all information relevant to the placing of process control equipment and case of interference with other work, proceed as directed by the ENGINEER and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the OWNER.
- B. Provide brackets and hangers required for mounting of equipment.
- C. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.
- D. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing, and



location of system components, their connections to the process equipment panels, cabinets, and devices, subject to the ENGINEER's approval. Certify that field wiring associated with the equipment is installed in accordance with best industry practice. Coordinate work under this section with that of the electrical work specified under applicable Sections of Division 26.

- E. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare and ultraviolet exposure on digital readouts.

### 3.2 TESTING

- A. Testing and Commissioning: Accomplished in accordance with the requirements of Section 01 70 00 "Execution and Closeout Requirements" and Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
- B. Testing shall be scheduled and coordinated with the OWNER/ENGINEER at least 2 weeks in advance. Provide qualified test personnel, instruments and test equipment, including manufacturer's services, as specified in the individual Specification sections.
- C. Where test reports show unsatisfactory results, the OWNER/ENGINEER will require the removal of all defective or suspected materials, equipment, apparatus, and their replacement with new items, all at no cost to the OWNER. The CONTRACTOR shall bear all the cost for any retesting.

### 3.3 TRAINING

- A. Training: Accomplished in accordance with the requirements of Section 40 61 26 - Instrumentation and Control System Training and Section 01 70 00 - Execution and Closeout Requirements.

**END OF SECTION**

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**SECTION 40 61 01**  
**INSTRUMENTATION AND CONTROL SYSTEM REFERENCES AND ABBREVIATIONS**

**PART 1 - GENERAL**

**1.1 SUMMARY - NOT USED**

**1.2 REFERENCES**

**A. Industry Standards and Codes**

1. **Applicability of Standards:** Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
2. **Publication Dates:** Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
3. **Copies of Standards:** Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  - a. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
4. **Abbreviations and Acronyms for Standards and Regulations:** Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the organizations responsible for the standards and regulations.

**B. STANDARDS**

1. **American National Standards Institute (ANSI):**
  - a. ANSI/ISA -101.01 - 2015 - Human Machine Interfaces for Process Automation Systems
  - b. B 16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
  - c. Supplement to C37.90, Relays and Relay Systems Associated with Electric Power Apparatus (IEEE Std. 313), C37.90a.
  - d. C39.5, Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation
  - e. ANSI 61 - Drinking Water System Components - Health Effects
2. **American Petroleum Institute (API):**
  - a. RP 520 - Recommended Practices for the Design and Installation of Pressure-Relieving Systems in Refineries.
  - b. RP 550 – Manual on Installation of Refinery Instruments and Control Systems.
3. **ASTM International, Inc. (ASTM):**
  - a. A 36 - Specification for Carbon Structural Steel
  - b. A 182 – Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
  - c. A 269 – Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

- d. A 276 – Specification for Stainless Steel Bars and Shapes
  - e. A 312 – Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
  - f. B 32 – Specification for Solder Metal
  - g. B 68 – Specification for Seamless Copper Tube, Bright Annealed
  - h. B 88 – Specification for Seamless Copper Water Tube
  - i. D 1047 – Specification for Poly(Vinyl Chloride) Jacket for Wire and Cable
4. American Society of Mechanical Engineers (ASME)
    - a. B 16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
    - b. B 16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  5. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)
    - a. EIA-STD-RS-455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices
    - b. TIA/EIA-604 - Fiber Optic Connector Intermateability Standards (FOCIS)
  6. Fiber Optic Association (FOA)
    - a. FOTP-86 Fiber Optic Cable Jacket Shrinkage
  7. Insulated Cable Engineers Association (ICEA)
    - a. ICEA S-97-682 - Utility Shielded Power Cables Rated 5 Through 46 kV
  8. International Electrotechnical Commission (IEC)
    - a. IEC 255-4 - Electrical Relays - Single Input Energizing Quantity Measuring Relays With Dependent Specified Time
    - b. IEC 60068 - Environmental testing
    - c. IEC 61000-4-5: Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
    - d. IEC 61131 - Programmable controllers
    - e. IEC 68-2-6 - Environmental Testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)
    - f. IEC 68-2-7 - Environmental Testing - Part 2-27: Tests - Test Ea and guidance: Shock
  9. Institute of Electrical and Electronics Engineers (IEEE)
    - a. IEEE Standard 383 - Flame Retardant.
    - b. IEEE Standard 37.90.1 -2012 - IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
    - c. IEEE Standard 802 - LAN/MAN Standards Committee
    - d. IEEE Standard 802.3 - IEEE Standard for Ethernet
    - e. IEEE Standard 1202 - Flame Testing of Cables for Use in Cable Tray
  10. International Organization for Standardization (ISO)
    - a. ISO/IEC 26300:2006 - Information technology -- Open Document Format for Office Applications (OpenDocument) v1.0
  11. Instrumentation Society of Automation (ISA)

- a. S5.1 – Instrument Symbols and Identification
  - b. S5.2 - Binary Logic Diagrams For Process Operations.
  - c. S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
  - d. S5.4 – Instrument Loop Diagrams
  - e. S5.5 - Graphic Symbols for Process Displays
  - f. S5.6 - Functional Requirements Documentation for Control Software Applications.
  - g. S7.3 – Quality Standards for Instrument Air
  - h. S8.1 – Instrument Enclosures for Industrial Environments
  - i. S20 - Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
  - j. S39.1 – Control Valve Sizing Equations
  - k. S39.2 – Control Valve Capacity Test Procedures
  - l. S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments
  - m. S51.1 - Process Instrumentation Terminology
  - n. RP 3.1 – Flow Meter Installations, Seal and Condensate Chambers
  - o. RP 7.1 – Pneumatic Control Circuit Pressure Test
  - p. RP12.6 – Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
  - q. RP 20.1, 20.2 – Specification Forms for Instruments
  - r. TR 20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments
12. Japanese Standards Association (JSA)
- a. JIS C 0911:1984 - Vibration Testing Procedure for Electric Machines and Equipment
  - b. JIS C0912:1984 - Shock Testing Procedure For Electric Machines And Equipment
13. National Electrical Manufacturers Association (NEMA)
- a. NEMA ICS 2-230.40
  - b. NEMA WC-63.1 - Performance Standard For Twisted Pair Premise Voice And Data Communications Cables
14. National Fire Protection Association (NFPA)
- a. NFPA 70 - National Electrical Code (NEC)
  - b. NFPA 70E - Standard for Electrical Safety in the Workplace
  - c. NFPA 79 - Electrical Standard for Industrial Machinery
15. National Electrical Manufacturers Association (NEMA)
- a. ICS 6 Enclosures for Industrial Controls and Systems
  - b. 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
  - c. ICS 1-101 Diagrams, Designations and Symbols
  - d. ICS 4 Terminal Blocks for Industrial Use.

- e. LS1 Low Voltage Surge Protection Devices
  - f. Control System 1 – General Standards for Industrial Control and Systems
16. Underwriters Laboratories, Inc. (UL)
- a. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.
  - b. UL 508, the Standard of Safety for Industrial Control Equipment
  - c. UL 508A, the Standard of Safety for Industrial Control Panels
  - d. UL 910 - UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.
  - e. UL 1581 VW 1 - Vertical Tray Cable Flame Test
  - f. UL 1283 Standard for Safety-Electromagnetic Interference Filters.
  - g. UL 1449 Third Edition Surge Protective Devices
  - h. UL 1666 - UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts.
17. United States Military Standard (MIL-STD)
- a. MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

C. Terminology Abbreviations

1. The abbreviations used in the Division 40 specifications or in any Section referencing Division 40, shall be as defined in ISA Standard S51.1, unless otherwise specified. Where terms used are not defined in ISA 51.1, or in these specifications, ANSI/IEEE Standard 100-1984, ANSI/ISA S50.1 or other ISA standards shall apply.
- a. AI: Analog Input
  - b. AO: Analog Output
  - c. CPU: Central Processing Unit
  - d. CSI: Control System Integrator
  - e. DI: Discrete Input
  - f. DO: Discrete Output
  - g. HMI: Human-Machine-Interface
  - h. I/O: Input/Output
  - i. OIT: Operator Interface Terminal
  - j. PLC: Programmable Logic Controller
  - k. TCP/IP Transmission Control Protocol/Internet Protocol
  - l. RTU: Remote Terminal Unit
  - m. UPS: Uninterruptible Power Supply
  - n. VFD: Variable Frequency Drive

D. Terminology Definitions

1. The definitions of terminology used in the Division 40 specifications or in any Section referencing Division 40, shall be as defined in ISA Standard S51.1, unless otherwise specified. Where terms used are not defined in ISA 51.1, or in these specifications, ANSI/IEEE Standard 100-1984, ANSI/ISA S50.1 or other ISA standards shall apply.

- a. Analog Device: Any sensor, transmitter, indicator, recorder, controller, computing relay, or control valve which transmits or receives an analog signal. Excludes the portion of a digital system or Input/Output subsystems.
- b. Analog Signal: A signal that has an infinite number of values and varies in strength.
- c. Control Circuit: Any circuit operating at 24 Vac or Vdc or more, whose principal purpose is the conveyance of information and not the conveyance of energy for the operation of an electrically powered device.
- d. Control Room: An environmentally controlled room intended for housing digital control equipment, computers, large control panels, etc., and generally intended to be regularly occupied by operators.
- e. Data Sheets: Data sheets as used in this specification shall comply with the requirements of ISA S20 as modified.
- f. Device: An electronic or mechanical apparatus designed to perform a specific measurement of control function.
- g. Discrete Signal: A signal that has only two values, on and off.
- h. Equipment: Machinery used in a process, e.g., pumps, mixers, fans, etc.
- i. Field: When used to refer to locations at the treatment facility, or in the transmission system, shall mean all outdoor locations, as well as all process and equipment areas. Unless otherwise specified, all areas shall be considered "field" locations except for administration and other office areas; control rooms; motor control centers and other electrical equipment rooms; dedicated HVAC rooms; and maintenance buildings.
- j. Field Termination Point: Termination of a run of raceway from an instrument panel to the vicinity of a field instrument.
- k. Fixed Input/Output: A PLC style consisting of a fixed number of Input/Output, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.
- l. HMI: Human-Machine-Interface. The control system hardware and software associated with providing the LCD-based interface between system users and the control system
- m. Loop: Any combination of interconnected transmitters, receivers, switches, alarms, indicators, controllers, computers, or final control elements.
- n. Operator Interface Terminal: A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.
- o. Panel: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified, the term "panel" shall be interpreted as a general term which includes flat panels, enclosures, cabinets, and consoles.
- p. PLC: Programmable Logic Controller. Field installed unit which monitors and controls devices located within the plant. The PLC control system shall contain

all logic necessary to monitor and control the system process located at the PLC location.

- q. Process: A progressively continuing operation that consists of a series of controlled actions systemically directed toward a particular result, e.g., a process to mix, filter, heat, and/or cool air to a particular condition.
- r. RTU: Remote Terminal Unit. Field installed unit which monitors and controls devices, located away from the plant at remote locations. The RTUs contain all logic necessary to monitor and control the system process located at the remote location.
- s. Subsystem: A discrete subdivision of a system and an assemblage of parts, devices, or software modules designed to perform one or more of the specific tasks required for the system to accomplish its functions.
- t. System: As assemblage of sometimes diverse parts, devices, or software modules serving a common set of measurement and control functions.
- u. Two-Wire Transmitter:
  - 1) A transmitter which derives its operating power supply from the signal transmission circuit and therefore requires no separate power supply connections.
  - 2) As used in this specification, two-wire transmitter refers to a transmitter which provides a 4 to 20 milliampere current regulation of signal in a series circuit with an external 24 volt direct current driving potential and a maximum external circuit resistance of 600 ohms.
- v. Unit: Any combination of equipment items interconnected in a predetermined manner, performing one or more controlled actions toward a particular result. A discrete subdivision of a process.

1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED

1.4 SUBMITTALS - NOT USED

1.5 QUALITY ASSURANCE - NOT USED

1.6 DELIVERY, STORAGE, HANDLING - NOT USED

1.7 SITE CONDITIONS - NOT USED

1.8 WARRANTY - NOT USED

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

**END OF SECTION**



**SECTION 40 61 21**  
**INSTRUMENTATION AND CONTROLS SYSTEM TESTING AND COMMISSIONING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Section Includes:**

1. This section covers the testing requirements for all devices and systems furnished and installed by the Control System Integrator as detailed in the Drawings and as described in the related work sections.
2. The Control System Integrator shall provide all labor and materials necessary to coordinate and perform the testing of the Process Control System as specified herein.
3. The Control System Integrator shall provide all test equipment necessary to perform the testing activities specified herein.
4. The Control System Integrator shall submit certified Instrument Calibration Certificates to the ENGINEER for field instruments and devices specified or shown on the Drawings immediately upon completion of calibration. Submit Instrument Calibration Certificates for existing instruments requiring re-calibration as well.
5. Receipt of any Instrument Calibration Certificates shall in no way imply acceptance of any work or of instruments supplied.
6. Each Instrument Calibration Certificates shall be signed and dated by an authorized representative of the Control System Integrator.

**B. Related Sections include but are not necessarily limited to:**

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 40 05 92 - General Control Panel Requirements for Pumping Systems
4. Section 40 61 01 - Instrumentation and Control System Abbreviations
5. Section 40 61 26 - Instrumentation and Control System Training
6. Section 40 61 96 - Control System Configuration
7. Section 40 61 93 - Control System Input/Output List
8. Division 26 Electrical

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.**

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

**A. Action Submittals**

1. Each Section submittal shall be complete, contain all of the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the

Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned un-reviewed.

2. The CONTRACTOR shall check shop drawings for accuracy and Contract Requirements prior to submittal to the ENGINEER. Errors and omissions on approved shop drawings shall not relieve the CONTRACTOR from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a Statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section submittals will be allowed per transmittal unless sections are indicated for grouping in the individual sections.
3. Startup Plan Submittal:
  - a. The CONTRACTOR shall submit a startup plan for OWNER/ENGINEER review. Upon successful review, the CONTRACTOR shall coordinate with Operations on an agreed upon date and time for commissioning each site.
4. Testing Plan and Schedule Submittal
  - a. Submit a Testing Plan and Schedule Submittal. The Testing Plan shall be made and approved before any testing shall be accepted. The Testing Plan, Schedule submittal shall, as a minimum, contain the following:
    - 1) Overview of the Process Control System, clearly describing the Control System Integrator's understanding of the project work and interfaces to other systems; and including a preliminary system architecture drawing and proposed project work schedule detailing all Control System Integrator's work activities.
    - 2) Approach to work clearly describing how the Control System Integrator intends to execute the work, including detailed discussion of switchover, startup, replacement of existing equipment with new, and other tasks as required by these specifications as applicable.
    - 3) Preliminary HMI software, PLC software, and PLC hardware submittal information shall be included solely for determining compliance with the requirements of the Contract Documents prior to beginning development of application programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the Control System Integrator of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved shall not be permitted without prior ENGINEER approval.
    - 4) Details of personnel assigned to the project and organizational structure including the Control System Integrator's project manager, project ENGINEER, and lead project technicians. Include resumes of each key individual and specify in writing their commitment to this project.
    - 5) Preliminary coordination meeting agendas as specified herein.
    - 6) Preliminary training plan
    - 7) Samples of shop drawings to be submitted in conformance with the requirements of the Specifications shall be submitted. At a minimum include samples of panel fabrication drawings, loop, and Input/Output

wiring diagrams.

- b. Exceptions to the Specifications or Drawings shall be clearly defined in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the ENGINEER. The acceptability of any device or methodology submitted as an "equal" or "exception" to the specifications shall be at the sole discretion of the ENGINEER. If no exceptions are taken to the Specifications or Drawings, the Control System Integrator shall make a statement indicating so. If there is no statement included by the Control System Integrator, it shall be interpreted by the ENGINEER to mean that no exceptions are taken.
- c. A Project Schedule shall be prepared and submitted using an ISO/IEC 26300:2006 formatted file. The schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. The Control System Integrator's schedule shall be based on and coordinated with the CONTRACTOR's schedules and must meet all field installation, testing, and startup milestones in those schedules.
- d. The Control System Integrator schedule shall illustrate all major project milestones including the following:
  - 1) Schedule for all subsequent project submittals: include in the time allotment, the time required for CONTRACTOR submittal preparation, ENGINEER's review, and a minimum of two complete review cycles.
  - 2) Proposed dates for all required project Coordination Meetings.
  - 3) Hardware purchasing, fabrication, and assembly (following approval of related submittals)
  - 4) Software purchasing and configuration (following approval of related submittals)
  - 5) Shipment of all instrumentation and control system equipment
  - 6) Installation of all instrumentation and control system equipment
  - 7) Duration and dates for all required testing activities. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed documentation of testing activities for review and approval by the ENGINEER prior to equipment shipment, startup, or subsequent project work.
  - 8) The Control System Integrator shall arrange the schedule to develop, test, troubleshoot, and train the OWNER's staff on the control system network, PLC and HMI applications. The timing of these coordination efforts shall be determined by the Control System Integrator. The Control System Integrator shall include all necessary costs to accommodate the minimum time slots in their overall project schedule. All time allotments shall exclude any legal holidays, or days lost due to delays caused by the CONTRACTOR.
  - 9) Include a schedule for system cutover, startup, and/or placing in service for each individual site under this Contract. At a minimum, include the

schedule for all work on the primary Operations Control Center, Backup Operations Control Center and associated work on new backup radio tower, radio link testing between all sites, 900 MHz radio and cellular modem installation and testing, HMI, OIT, PLC programming timeline, HMI server transition to FactoryTalk testing, and all other related testing.

10) Schedule for all training including submittal and approval of O&M manuals, factory training, and field training

5. Testing Documentation Submittals

- a. System Test Plan: The Control System Integrator shall prepare and submit for review a System Test Plan.
- b. Test Procedures: The Control System Integrator shall prepare and submit for review a Test Procedures.
- c. Test Reports: The Control System Integrator shall prepare and submit for review a Test Report.

B. Commissioning Submittals

1. Provide Control System Test Plan, procedures for system testing, and test reports in accordance with Section 01 70 00 - Execution and Closeout Requirements and as specified in Part 3 of this Section.
2. Following the network, instrumentation and control system checkout and start-up, the CONTRACTOR shall perform a complete system test in the presence of the OWNER/ENGINEER to verify that all equipment and software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Commissioning shall be performed on a site by site basis.
  - a. Commissioning shall begin only after networking equipment, all instruments and control panels are installed, wired and previously tested by the CONTRACTOR, in accordance with Paragraph 1.02 of this Section.
  - b. CONTRACTOR shall submit to the ENGINEER a schedule for Commissioning, including a proposed start date, at least three weeks in advance.
3. Commissioning shall include, as a minimum, the following checks:
  - a. All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.
  - b. All instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings. The calibration of analog devices shall be verified including the zero and span.
  - c. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.
  - d. All analog loops shall be verified at each termination point at 0%, 25%, 50%, 75%, and 100% signal levels.
4. CONTRACTOR shall provide the following documentation for use during the Commissioning effort.
  - a. Complete panel schematic and internal point-to-point wiring interconnect drawings.
  - b. Complete electrical control schematics in accordance with JIC standards.

- c. Complete panel layout drawings.
  - d. Complete field wiring diagrams.
  - e. Complete instrument loop diagrams.
  - f. Completed Calibration/Recalibration Certificates for all field and panel devices that require adjustment or calibration.
  - g. CONTRACTOR shall provide one set of Commissioning documentation for the OWNER's personnel, one set for the ENGINEER's use, one set for field use, and the required number of sets for the CONTRACTOR's use.
  - h. The drawings corrected and modified during Commissioning shall form the basis for the "As-Built" record drawing requirement.
5. All PLC/RTU hardware and software shall be thoroughly tested to verify proper operation as an integrated system. System testing shall include, as a minimum, the following:
- a. All digital inputs shall be activated at the field element to verify proper response to the status change on graphic displays, reports, and in automatic control algorithms.
  - b. All analog inputs shall be tested at the field transmitter over a full range to verify proper response on graphic displays, reports, and in automatic control algorithms.
  - c. All digital and analog outputs shall be forced to verify proper control operation.
  - d. Communications, including PLC/RTU data highway, computer local area network, PLC/RTU remote I/O, and serial communications shall be tested between all components, including existing equipment.
  - e. Alarm displays and printing shall be tested for all analog and digital alarm points.
  - f. All automatic control algorithms shall be completely tested over various ranges and input conditions to verify proper operation. Graphic displays shall be observed to verify proper response to automatic control operations.
  - g. All historical data collection, trending, computation, totalizers and reporting functions shall be checked and tested to confirm proper operation and accuracy of the data.
6. Any defects or problems found during the Commissioning effort or field test shall be corrected by the CONTRACTOR and then retested to demonstrate proper operation.
7. Following testing and demonstration of all system functions, the new control system shall be fully operational for a continuous 48-hour period. The Field Demonstration Test specified below shall not begin until the continuous 48 hour proving run has been successfully completed and OWNER and ENGINEER agree that the Field Test can begin.
8. Cutover Sequence Plan
- a. If applicable, the Control System Integrator will review the specified construction sequence and develop a submittal plan of switchover the existing PLC's and Control Sequence without interruption to control and monitoring of the system.

C. Closeout Submittals

1. Record Documentation
  - a. The Control System Integrator, within 30 days after successful completion of Site Demonstration Test (SDT), shall submit a preliminary version of the Record Documents. Final Record Documents shall be submitted prior to the conclusion of the Site Availability Demonstration (SAD). The SAD shall not be considered complete until the final Record Documents submittal has been Successfully Reviewed.
  - b. The System Operator's Manuals shall describe the configuration and all functions for the systems and equipment provided. Functional descriptions shall include algorithms necessary to fully understand the functions. The manuals shall be organized for quick access to each detailed description of the operator's procedure. The manuals shall be limited only to description of procedures for functions that are performed by the operator. The System Operator's Manuals shall serve as a complete instruction to the system and equipment and shall describe in detail the operator interfaces and operator procedures. In addition to the Operator interaction sequences, the following shall be provided, as a minimum:
    - 1) Summary description of all major functions
    - 2) Presentation of data on displays.
    - 3) Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.
    - 4) Description of the hardware configuration and device switching capabilities.
    - 5) Description of every message and alarm that the system is capable of outputting, an explanation of what the message indicates, and what action the system operator should take.
  - c. System Administrator Guide:
    - 1) The System Administrator Guide shall be a user's manual for all the corresponding systems programs. It shall include information on system generation from file backups, starting and bootstrapping the system, editing and expansion techniques (including display/report compiler, database, and applications edit), batch mode operation of software utilities, and troubleshooting to be used in conjunction with the system dumps, error and abort messages. User instructions for each of the peripherals and for all Software ENGINEER procedures shall be in the guide.
  - d. Software support materials:
    - 1) Program Media:
      - a) The Control System Integrator shall furnish complete sets of program media documentation. These documents shall include source of all programs written by the Control System Integrator specifically for the proposed system. This includes, RTU and PLC programs, HMI scripting, OIT applications, and objects of all programs necessary for the operation and maintenance of the systems programs. If any changes are made to programs during system test and acceptance,

the Control System Integrator shall provide, within [5] [choose a number] days, corrected copies of source, object, and system media.

- 2) Program Listings:
  - a) Each program listing shall include revision information. Each time a change is made in the listing, its revision level shall be documented by the party making the change. Program listings will include all in-program comments and documentation, and must be clearly understandable by programmers familiar with the language used. Undocumented code is not acceptable.
- 3) Programmer Manuals:
  - a) The purpose of these manuals will be to enable systems and applications programmers, to maintain, modify, and expand the capacity and functionality of the system. These manuals shall comprise the standard manuals furnished by the computer system manufacturer covering the Operating System, Utilities, Diagnostics, and High Level Language(s) supplied, together with Control System Integrator furnished manuals that are specific to the system. The manuals shall include descriptions of the procedures to be used for:
    - i. Computer system startup, restart, manual failover, and operation.
    - ii. Modifying and expanding the system databases and testing revised versions.
    - iii. Defining, linking to the database, and testing revised and new displays, logs, reports, data acquisition, process control, and data processing procedures including the addition of communication links, CFEs, RTUs, PLC's, and Input/Output points.
    - iv. System operational troubleshooting including descriptions of the system error messages and the interpretation of crash dumps.
    - v. Instructions for configuring and rebuilding servers and workstations as if starting a new system, as well as rebuilding from backups (this will apply to peripherals applicable to the system as a whole, including network items).
    - vi. Provide effective procedures and techniques for creating, expanding, and editing control system and PLC applications. Include useful backup procedures required for system recovery.
- 4) System Configuration Inventory List:
  - a) An inventory list shall be furnished for all contract material, software, documentation, spare parts, and test equipment. Hardware identification of each unique module by serial number and each software unique module shall be included on the list. The inventory list shall include, but not be limited to, the following information:
    - vii. Manufacturer's name, part number, and serial number
    - viii. Quantity of units supplied with the deliverable System/subsystem

- ix. Software modules supplied
  - x. Operating system software provided for all CPUs/microprocessors
  - xi. Operating systems enhancements provided
  - xii. System documentation supplied
  - xiii. Applicable cabinet, rack number or slot, and cables.
- b) The inventory list, which shall be prepared and updated by the Control System Integrator, shall be subdivided by hardware, software, test equipment, spares, documentation, and training courses. Each of these major divisions shall be further subdivided to the individual deliverable item level. Each item must be defined in sufficient detail to permit identification in shipping documents and inventory checks. The organization of the inventory list shall include provision for annotating each item with forecast and actual dates for:
- xiv. Review (Documentation)
  - xv. Shipping and Delivery (All items Except Documentation)
  - xvi. System Testing (Hardware and Software)
  - xvii. Site Demonstration Tests (Hardware and Software)
  - xviii. Final Acceptance (Spares, Documentation, etc.)
  - xix. Delivery (Training Courses).
- c) A preliminary version of the System Configuration Inventory List that demonstrates the form and content to be provided shall be submitted for review. A completed System Configuration Inventory List shall be submitted no later than 30 days prior to the scheduled start of System Testing. The SDT shall not be initiated until the System Configuration Inventory List submittal has been Successfully Reviewed. A System Configuration Inventory List updated to reflect any additions or changes during system installation shall be included as part of the Record Documents.

## 1.5 QUALITY ASSURANCE

### A. Control System Availability Requirements:

1. A fundamental objective of the Control System Integrator's proposed system design shall be to ensure that no single equipment failure or temporary error condition can disable the system operation or generate any spurious control commands to the system equipment.
2. Single Point of Failure:
  - a. The control system equipment configuration shall prevent any single hardware or software failure from causing loss of any system function or from causing overall system malfunction. Single hardware failures may cause loss of specific communication channels temporarily until failed equipment is replaced.
3. Control System Operational Checks: The Control System Integrator's proposed system shall continually check the operation of all devices in the system and report any problem to the user. Upon detecting a malfunction, the failed operation shall be



attempted a number of times (programmable) in order to determine whether the malfunction is temporary or permanent. Permanent malfunctions shall be alarmed and logged. Temporary malfunctions shall not be alarmed but shall be logged for maintenance purposes. Failed devices shall be automatically replaced by spare or backup devices if such devices are available.

- B. System Availability: During the System Availability Demonstration, the control system shall achieve an average availability rate for all functions of at least 99.95%. This is equivalent to a total downtime of approximately 4 hours per year for the System.

#### 1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

#### 1.7 SITE CONDITIONS - NOT USED

#### 1.8 WARRANTY - NOT USED

### PART 2 - PRODUCTS - NOT USED

### PART 3 - EXECUTION

#### 3.1 STARTUP PERSONNEL REQUIREMENTS:

- A. During the start-up phase, the Control System Integrator shall provide a minimum of 2 people on site full-time.
- B. OWNER will provide personnel in the control room (dedicated to testing activities), and other personnel in the field to support installation and testing activities, such as to observe and inspect the work associated with installation of the PLC's and assisting with end-to-end and control software tests.
- C. ENGINEER will provide testing support as required.

#### 3.2 TESTING GENERAL

- A. Confirmation of an operational control system is dependent upon results obtained through the testing activities specified in this section. All equipment furnished shall be tested at the factory prior to shipment to the project site and at the project site as specified herein. Unless otherwise specified in the individual specification sections, all equipment provided shall be tested at the factory and at the project site as a single fully integrated system.
- B. The Control System Integrator shall formally notify the OWNER and ENGINEER in writing through the project administration web site of their intent to commence each phase of testing, witnessed and un-witnessed, specified herein. Testing shall not be permitted to proceed unless the OWNER and ENGINEER confirm all required submittals anticipated up to that point in the construction activities have been received by the OWNER and ENGINEER and favorably reviewed.
- C. All witnessed testing dates shall be scheduled with the OWNER and ENGINEER.
- D. At a minimum, the testing shall include the following:
  - 1. Un-witnessed Factory Test (UFT)
  - 2. System Integration Test (SIT)
  - 3. Factory Acceptance Test (FAT)

4. Operational Readiness Test (ORT)
  5. Functional Demonstration Test (FDT)
  6. 30-day Site Acceptance Test (SAT)
- E. Each test shall be in the cause and effect format. The individual conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will be deemed to have been satisfied.
  - F. The Control System Integrator shall provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide a suitable means of simulation. These simulation techniques shall be defined in the test procedures.
  - G. The Control System Integrator shall coordinate all required testing with the General CONTRACTOR, all affected subcontractors, the ENGINEER, and the OWNER.
  - H. The Control System Integrator shall furnish the services of field service engineers, all special calibration and test equipment, and labor necessary to perform the field tests.
  - I. All tests shall be conducted in accordance with approved (by ENGINEER and OWNER) procedures, forms, and checklists as submitted in accordance with the requirements of Section 40 61 00 - Instrument and Control Systems General Provisions.
  - J. Each test to be performed shall be described and a space shall be provided after the description for sign-off by the appropriate parties after its satisfactory completion. Include punch list forms with the test procedures to document issues that arise during the testing. Punch list forms, at a minimum, shall include a specification cross reference; an issue description field; a resolution description field; and a sign-off area for the Control System Integrator, OWNER, and ENGINEER.
  - K. Copies of the signed-off test procedures, forms, checklists and other documents required herein shall constitute the required testing documentation. The test result forms shall be submitted to the ENGINEER for approval within 10 days of completion of each test.
  - L. The ENGINEER reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required, to determine compliance with the functional requirements of the overall system. This testing, if necessary, to determine compliance with the specified requirements, shall be performed at no additional cost to the OWNER. The ENGINEER's decision shall be final regarding the acceptability and completeness of all testing.
  - M. No equipment shall be shipped to the project site until the ENGINEER and OWNER have received all test results and other documentation of successful factory testing and given approval that the system is ready for shipment.
  - N. Correction of Deficiencies
    1. All deficiencies in workmanship and items not meeting specified testing requirements shall be corrected to meet specified requirements at no additional cost to the OWNER.
    2. Testing, as specified herein, shall be repeated after correction of deficiencies until the specified requirements are met. This work shall be performed at no additional cost to

the OWNER.

### 3.3 FACTORY TESTING UN-WITNESSED FACTORY TEST (UFT)

- A. Prior to shipment of the equipment, the entire system, except primary elements, final control elements, and field-mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
- B. All panels, consoles, and assemblies shall be inspected and tested to verify their conformance with related submittals, Specifications, and Drawings.
- C. During the tests, all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.
- D. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.
  - 1. All panels and enclosures being provided shall undergo a thorough inspection to verify the integrity of the cabinet enclosures, frame structures, paint work and finish, etc. Additionally, the Control System Integrator shall review the panel drawings with the OWNER and/or ENGINEER to ensure they accurately reflect the panel layout and wiring.
  - 2. Panel wire pull tests shall be performed on all wiring to ensure all wiring has been connected to the appropriate torque to prevent wires from coming loose.
  - 3. For panels provided in new enclosures, heat loading tests shall be performed to ensure proper cooling and ventilation is being provided.
  - 4. UPSs shall be tested with all equipment connected to verify the UPSs have been sized correctly to maintain the specified run time.
  - 5. An I/O point checkout of at least 50% of each I/O module shall be performed to verify proper operation of the input/output points. The verification of the signals will be accomplished via the use of the PLC programming software. At a minimum, the I/O checkout shall consist of four steps.
    - a. Digital input signals shall be temporarily connected within the termination connections of the PLC panels and verification of proper alarming, statuses, etc., shall be performed utilizing the tools available in the PLC programming software.
    - b. Analog input signals shall be connected to a signal generator at the termination connections and signals shall be verified at zero%, 25%, 50%, 75%, and 100% of full scale. The appropriate scaled value shall be verified utilizing the tools available in the PLC programming software.
    - c. Digital output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel by connecting a digital multi-meter to measure the continuity at the terminations, thus verifying the command from the PLC has properly executed the contact closure.
    - d. Analog output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel

by utilizing a digital multi-meter to measure the current/voltage generated at the termination points.

- E. All control panels provided or modified under the related sections of Division 40 shall be included in these tests.
- F. Upon successful completion of the UFT, the Control System Integrator shall submit a copy of the test results to the OWNER and ENGINEER.

#### 3.4 FACTORY TESTING SYSTEM INTEGRATION TEST (SIT)

- A. The SIT shall be conducted a minimum of 3 weeks before the Factory Acceptance Test. The test shall be an un-witnessed test, and the Control System Integrator shall include time within his construction schedule for this test.
- B. The purpose of the SIT is to allow the Control System Integrator to verify the functionality, performance, and stability of the hardware and software as a complete integrated system prior to the FAT. The Control System Integrator will load the application software on the PLCs, control system servers, and historian server. The entire system will then be tested. All process control strategies shall be simulated to ensure proper operation.
- C. The Control System Integrator shall utilize the approved test procedures to conduct the testing and document the results.
- D. Minimum testing to be performed during the SIT shall include, but not be limited to, the following:
  - 1. Verification of proper scanning, communication, and complete data acquisition of the entire system
  - 2. Verification of all redundant functionality of components
  - 3. Verification of proper power failure recovery
  - 4. Verification of proper indication for communication error issues
  - 5. A complete I/O point checkout shall be performed to verify proper operation of each input/output point. The I/O checkout shall consist of four steps.
    - a. Digital input signals shall be jumpered within the termination connections of the PLC panels and verification of proper alarming, statuses, etc., shall be performed at the HMI.
    - b. Analog input signals shall be connected to a signal generator at the termination connections and signals shall be verified at zero%, 25%, 50%, 75%, and 100% of full scale. The appropriate scaled value shall be verified at the HMI. Simultaneously, verification of alarming shall occur. The alarming verification shall, at a minimum, include High High, High, Low, Low Low, Rate of Change, and Alarm Deadband.
    - c. Digital output signals shall be initiated by the user from the HMI system. Verification shall occur within the PLC panel by connecting a digital multi-meter to measure the continuity at the terminations, thus verifying the command from the PLC has properly executed the contact closure.
    - d. Analog output signals shall be initiated by the user from the HMI system. Verification shall occur in the PLC panel by utilizing a digital multi-meter to measure the current/voltage generated at the termination points.

- E. Upon successful completion of the SIT, the Control System Integrator shall submit a copy of the test results to the OWNER and ENGINEER and request the scheduling of the FAT as specified herein.

### 3.5 FACTORY TESTING FACTORY ACCEPTANCE TEST (FAT)

- A. The Control System Integrator shall plan for a Functional Acceptance Test to last for at least five working days.
- B. The purpose of the FAT is to verify the functionality, performance, and stability of the hardware and software. The system shall operate continuously throughout the FAT without failure, except where initiated in accordance with the established test procedures. Any unanticipated failures during the FAT may, at the OWNER and/or ENGINEER's discretion, result in the FAT being deemed unsuccessful. Successful completion of the FAT, as determined by the OWNER and ENGINEER, shall be the basis for approval of the system to be shipped to the project site.
- C. The FAT shall be performed by the Control System Integrator conducted at the Control System Integrator's facility. All system tests performed and specified for the UFT and the SIT shall be repeated in the presence of the ENGINEER and OWNER at the FAT.
- D. The Control System Integrator shall notify the ENGINEER and OWNER in writing that the system is ready for the FAT. The ENGINEER and OWNER shall schedule a test date within 14 days of receipt of notification. At the time of notification, the Control System Integrator shall submit any revisions to the detailed test procedures previously approved by the ENGINEER and OWNER.
- E. The various tests performed during the FAT shall be designed to demonstrate that hardware and software fulfill all the requirements of the Contract Documents. The test conditions shall resemble, as closely as possible, the actual installed conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no cost to the OWNER.
- F. Tests to be performed during the FAT shall include, but not be limited to, the following:
  - 1. A system audit to verify all components have been staged for the test
  - 2. Inspection of the system inventory to verify all components have been documented properly with correct model numbers, serial numbers, etc.
  - 3. For each hardware enclosure, inspection shall include, but not be limited to, enclosures, frame structure, paint work and finish, dimensions, and hardware operability (i.e., fans, door hinges, keylocks, etc.).
  - 4. For each subpanel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry-accepted practices.
  - 5. Demonstration of operability of all equipment
  - 6. 100% point check of I/O, including wiring. Analog signals shall include verification of zero%, 25%, 50%, 75%, and 100% of scale. Additionally, out of range testing (over and under scale) shall be accomplished.

7. Demonstration of the ability to monitor and change at least 20 pieces of digital and analog data in each PLC from the HMI software at all operator workstations
  8. Demonstration of the ability to share data between operator workstations and servers
  9. Demonstration of the ability of each workstation to print reports on all designated network report printers.
  10. Demonstration of the ability for each workstation to read and write to and from designated files from other workstations on the network
  11. Demonstration of the operability of all mass storage equipment
  12. Demonstration of communication failure and system restart
  13. Demonstration of total power failure and recovery (the UPS shall be removed for this test)
  14. Demonstration of the failover capabilities of all redundant components
  15. Demonstration of the ability of the UPSs to meet the runtime requirements upon loss of power
  16. Demonstration of logical failure conditions for control strategies (i.e., instrument failures, equipment failures, loss of communication between the I/O Server and the controller, loss of peer-to-peer communication, etc.)
- G. During the test, for a period of time equal to at least 20% of the test duration, the ENGINEER's and OWNER's representative shall have unrestricted access to the system to perform any additional testing desired or to re-test any previously tested components.
- H. All analog control panels shall be included in these tests.
- I. All deficiencies identified during these tests shall be corrected and re-tested prior to completing the FAT as determined by the OWNER and ENGINEER.
- J. The following documentation shall be made available to the ENGINEER and OWNER at the test site both before and during the FAT:
1. All Contract Documents, addenda, and change orders
  2. Master copy of the Test Procedures
  3. Bill of Material for all hardware and software to be tested, including make, model, and serial number
  4. Design-related Hardware Submittal applicable to the equipment being tested
  5. Software Licenses
  6. Software Documentation Submittal
- K. The daily schedule during the test shall be as follows:
1. Morning meeting to review the day's test schedule
  2. Scheduled tests and sign-offs
  3. End of day meeting to review the day's test results and to review or revise the next day's test schedule
  4. Unstructured testing period by the witnesses
- L. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the ENGINEER and OWNER.

### 3.6 FIELD TESTING OPERATIONAL READINESS TEST (ORT)

- A. Following installation of the process control system components and prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, wired, calibrated, tested, etc., and documented) that it is installed and ready for the FDT as defined below.
- B. Loop/Component Inspections and Tests: the entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related approved submittals and these Specifications.
- C. The Loop/Component Inspections and Tests shall be implemented using ENGINEER-approved forms and checklists. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include, at a minimum, the following information and check-off items with spaces for sign-off by the system supplier:
  - 1. Project Name, Test Date, Control System Integrator Name, and Lead Control System Integrator Technician Name
  - 2. Loop Number.
  - 3. Tag for each component.
  - 4. Check-offs/sign-offs for each component: Tag; installation; termination (wiring and tubing); scale, range, and setpoint as applicable; and calibration/ adjustment (four-point for analog, set point for switches) rising and falling.
  - 5. Check-offs/sign-offs for the loop: Panel interface terminations; I/O interface terminations; I/O signal operation; inputs/outputs operational (received/sent, processed, adjusted); total loop operation; process controller scaling and adjustment; and space for comments.
  - 6. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign-off by the Control System Integrator.
    - a. Project Name
    - b. Loop Number
    - c. Component Tag Number of I/O Module Number
    - d. Component Code Number Analog System
    - e. manufacturer (for Analog system element)
    - f. Model Number/Serial Number (for Analog system)
    - g. Summary of functional requirements shall include, but not be limited to, scale and chart ranges of indicators, recorders, and transmitters/converters; functions of computing elements; and parameters of controllers (i.e., proportional, integral, derivative, reverse/forward acting, etc.)
    - h. Calibrations shall include testing of analog input and output signals at zero, 10, 50, and 100% of span. Where appropriate, discrete input signals shall include details regarding actual trip points and reset points.
    - i. Space for comments
    - j. Space for sign-off by the Control System Integrator

- D. The Control System Integrator shall maintain the Loop Status Reports at the job site and make them available to the ENGINEER and OWNER at any time.
- E. These inspections, calibrations, and tests do not require witnessing, however, the OWNER and ENGINEER reserve the right to witness as they deem necessary. The OWNER and ENGINEER may, at their discretion, review Loop Status Reports and spot check the test process periodically. Any deficiencies found shall be corrected by the Control System Integrator prior to commencement of the FDT.
- F. Prior to checkout of the I/O to the HMI, the Control System Integrator shall thoroughly test all I/O from the field device to the PLC terminals, and verify the PLC is powered up and the PLC is communicating to the HMI servers. After the Control System Integrator has successfully tested all I/O from the field devices to the PLC terminals, the Control System Integrator test all I/O from the HMI to the field device. Should this test prove to be unsuccessful, the Control System Integrator and
- G. Control System Integrator shall test from the HMI to the terminations located in the OWNER's termination cabinet, and the Control System Integrator shall inform the OWNER in writing of the discrepancy with the existing field wire.
- H. Remote Manual start/stop, open/close commands of all devices controlled by the control system shall be verified by the Control System Integrator during the ORT.
- I. For all panels with enclosures (new and existing) modified by this contract, heat load tests shall be performed to ensure proper cooling/ventilation is being provided.
- J. Upon successful completion of the ORT, the Control System Integrator shall submit a record copy of the test results to the OWNER and ENGINEER and request the scheduling of the FDT as noted in the following section.

### 3.7 FIELD TESTING FUNCTIONAL DEMONSTRATION TEST (FDT)

- A. Prior to the 30-day Site Acceptance Test(s), the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the ORT.
- B. Once a process area has been started up and is operating, a witnessed FDT shall be performed on that system to demonstrate that it is operating and is in compliance with these Specifications. A witnessed FDT shall be performed on each process area. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- C. Loop-specific and non-loop-specific tests shall be conducted in the same manner as specified under FAT, except that the entire installed system shall be tested and all functions demonstrated using live field data to the greatest extent possible.
- D. Updated versions of the documentation specified to be provided for during the factory tests shall be made available to the ENGINEER at the job site both before and during the tests. In addition, one copy of all O&M Manuals shall be available for reference at the job site, both before and during testing.
- E. The daily schedule specified to be followed during the factory tests shall also be followed during the FDT.
- F. During the FDT, a demonstration of communication failure and recovery shall be



accomplished. This test shall be scheduled and coordinated with OWNER's personnel to minimize the impact on plant operations.

- G. Following initial startup, the entire process control system shall operate for a continuous 100 hours without failure before this test will be started.
- H. Punch list items and resolutions noted during the test shall be documented on the Punch list form. In the event of rejection of any part or function test procedure, perform repairs, replacement, and/or retest within 10 days.
- I. Upon successful completion of the FDT, the Control System Integrator shall submit a copy of the test results to the OWNER and ENGINEER and request the scheduling of the SAT as noted in the following section.

### 3.8 FIELD TESTING 30-DAY SITE ACCEPTANCE TEST (SAT)

- A. After completion of the Operational Readiness and Functional Demonstration Tests, the system shall undergo a 30-day Site Acceptance Test (SAT), under conditions of full plant process operation, without a single non-field-repairable malfunction.
- B. During this test, plant operations and Control System Integrator personnel shall be present as required to address any potential issues that would impact the overall system operation. Provide personnel for this test who have an intimate knowledge of the hardware and software of the system. When not on site, provide cell phone/pager numbers that the OWNER personnel can use to ensure that support staff is available by phone and/or on site within four hours of a request by operations staff.
- C. While this test is proceeding, the ENGINEER and OWNER shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain the responsibility of OWNER and the decision of plant operators regarding plant operations shall be final.
- D. Any malfunction during the tests shall be analyzed, documented and corrected. The ENGINEER and/or OWNER will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. Any malfunction during this 30-consecutive-day test period which cannot be corrected within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction. Upon completion of repairs, the SAT will be re-started from the date on which the malfunction(s) were successfully corrected, and the OWNER and ENGINEER had accepted and signed off on the repairs.
- F. In the event of rejection of any part or function, perform repairs or replacement within 10 days.
- G. All database, process controller logic, and graphical interface system errors must be functioning as required per the specifications prior to the start of each test period. The 30-day test will not be considered successful until all data base points and logic functions are tested and verified to be correct.
- H. The total availability of the system shall be greater than 99.5% during this test period. Availability shall be defined as follows:

Availability in percent =  $100 * (\text{Total Testing Time} - \text{Down Time}) / \text{Total Testing Time}$

- I. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided shall not contribute to the availability test times above.
- J. A failure is the inability of a component to perform its function regardless of the cause or severity of the failure.
- K. Failures may range in severity from loss of a single keyboard contact, to inoperability of a workstation or print device, to complete inoperability.
- L. Failures may be caused by hardware or software faults. Software faults will be charged against the appropriate hardware component.
- M. Failures may be continuous or intermittent. An intermittent failure is a failure that occurs and then disappears before corrective maintenance can be completed. Examples of intermittent failures include, but are not limited to, the following:
  - 1. Communication errors caused by defective master station equipment.
  - 2. "Sticky" keyboard contacts.
  - 3. Peripheral device errors
  - 4. Operating system errors
- N. Downtime is the period of time between notification that a failure has occurred and notification that repair has been completed.
  - 1. For intermittent failures, downtime is the accumulation of the greater of the actual duration of each intermittent failure or 15 min. per occurrence. This accumulation starts at failure modification and ends at repair complete notification, subject to verification of the repair by the OWNER.
  - 2. Verify the end of downtime by testing repairs.
- O. A component is any equipment that is consistent in nature and function as those specified. Component examples include, but are not limited to, operation workstations, PLCs, disk drives, the master station computers, printers, data network, modems and similar hardware.
- P. Availability is the fraction of operating time a component is capable of performing its intended function.
- Q. A PLC unit is considered down and downtime will be recorded upon occurrence of any of the following:
  - 1. Errors in data translation
  - 2. Loss of numerical data
  - 3. Failure to perform logic
- R. Throughout the duration of the 30-day SAT, no software or hardware modifications shall be made to the system without prior approval from the OWNER and ENGINEER.
- S. Upon successful completion of the 30-day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.
- T. Certification of Installation: Following successful completion of the 30-day test, issue a

Certification of Installation. Certification shall be on corporate letterhead and signed by an officer of the firm. Certification shall state that the process control system has been completed in conformance with plans and specifications. Certification shall be submitted to the ENGINEER as specified herein.

- U. Work Scope: Provide engineering, furnishing, installing, PLC programming, calibrating, adjusting, testing, documenting, starting up, training, and all related activities required for a complete Control System for the Project.

**END OF SECTION**

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**SECTION 40 61 26**  
**INSTRUMENTATION AND CONTROL SYSTEM TRAINING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Provide all equipment, materials, incidentals and labor, necessary to perform and coordinate the overall system training for the Instrumentation and Control System.
- B. The CONTRACTOR'S Control Systems Integrator shall meet all the requirements of this Section. The training program provided shall be comprehensive covering the operation and maintenance of all elements of the instrumentation and control system. Several specific requirements for the training program are listed below:
  - 1. Training classes shall be tailored to the specific needs of the class participants. Separate curricula shall be developed for operators, field maintenance staff, and control system administrators.
  - 2. All training classes shall be completed prior to the start of Functional Demonstration Test (FDT).
  - 3. All instructors shall be highly qualified technical training with demonstrated expertise in not only control system functionality but also professional training techniques. During training class periods, trainers shall have no other duties that would interrupt training. Training shall not be combined with other activities such control system configuration or startup. Vendor provided training shall be conducted by factory authorized and certified trainers. Resumes and evidence of qualifications of instructors shall be provided as part of the training plan.
  - 4. Complete, professional, training materials shall be provided for all training classes including course outline and schedule, training manuals (in addition to control system documentation), and review/testing materials. The training manuals shall be designed to not only assists the student's comprehension of the course material but also to serve as reference documents after the completion of training. Training materials shall be provided to students at least one (1) week prior to class. The Owner reserves the right to make additional copies of all training materials.
  - 5. Training courses shall be a combination of classroom and hands-on training. To the furthest extent possible, hands-on training shall utilize components derived from hardware/software specified under this Contract.
- C. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements: Comply with the submittal requirements of Section 01 31 00 - Project Management and Coordination, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
- B. Control Systems Integrator shall prepare and submit an overall training plan. The training plan shall include a complete description of all training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools available (simulators, self-paced modules, personal computer-based training, etc.)
- C. The Owner shall review the training plan for assurance that the training planned by the Control System Integrator shall meet the training needs. Special emphasis shall be placed on review of the qualifications of the proposed instructors. If a concern arises about the qualifications of particular instructors, the Control System Integrator shall provide digital video of classes taught by the proposed instructors. If the Owner determines that the proposed instructors are not sufficiently qualified to conduct the specified training courses, the Control System Integrator shall identify alternate qualified instructors for approval.

1.5 QUALITY ASSURANCE - NOT USED

1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

1.7 SITE CONDITIONS - NOT USED

1.8 WARRANTY - NOT USED

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 TRAINING

- A. Training: Accomplished in accordance with the requirements of Section 01 70 00 - Execution and Closeout Requirements.
- B. General
  - 1. The cost of all training, including travel and hotel costs, for Owner's personnel shall be included in the Contract price. Where practical, the training and instruction shall be directly related to the system being supplied.
  - 2. Training shall be divided into three different categories:
    - a. Manufacturer's training
    - b. Project specific training
    - c. Equipment specific training
  - 3. All vendor provided training shall be coordinated with Owner at least 8 weeks prior to the actual training. Project specific training shall be conducted at the Owner's facilities.
  - 4. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the owner's working schedule. As such, some training classes may require multiple sessions to accommodate owner's staff.

5. Provide detailed training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
6. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.
7. The Owner reserves the right to use video recording to video all training sessions conducted onsite. All training videos shall become the sole property of the Owner.

### 3.2 PROJECT SPECIFIC TRAINING:

#### A. Training Manuals

1. Comprehensive training manuals shall be provided for all training courses. The manuals shall be professionally written to present the course material in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and shall additionally serve as reference material after the training has been completed. It shall not be acceptable for the Control System Integrator to use system technical documentation solely as the training manuals since system documentation is generally not written in an instructional format. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format.

#### B. Required Training Courses

1. Training courses shall be tailored to meet the specific needs of owner's personnel. The specific categories and number of personnel in each group category are identified in the following paragraphs. Class sizes shall be restricted to the number of students that can easily be accommodated. Classes that involve extensive hands-on activities (such as operator training, maintenance training, and software engineering) shall be limited to five (5) students per class. Supervisor and overview courses may include up to ten (10) participants. At least two (2) sessions of each course shall be presented to satisfy class size restrictions and conflicts in Owner's personnel scheduling. Additional sessions shall be presented if required to accommodate the total number of personnel identified for each course.
2. All training classes shall be scheduled Monday – Thursday between 8:00 a.m. and 3:30 p.m. Each individual daily training session shall be a minimum duration of two hours and a maximum duration of five hours.
3. The intent of the training program is to provide owner's personnel with comprehensive instruction in all subjects and areas necessary for the efficient configuration, maintenance, and use of the new system. If the Contractor's standard training curriculum includes courses in addition to those discussed below and which are necessary for the efficient configuration, maintenance, and use of the control system, the Control System Integrator shall also provide these courses. Following is a description of the categories of training to be provided.

#### C. Operator Training

1. Training courses shall be presented that will instruct the system operators in the efficient operation of all aspects of the system. The course material shall include not only the general operation of the system but also the operation of the specific system features incorporated in the system. In particular, the operator training shall include

instruction on the use of all operational functionality including, but not limited to system navigation, equipment monitoring, control, alarm logging, trending, and the process displays, database, reports, and system software.

### 3.3 EQUIPMENT TRAINING

- A. Primary Sensors/Transducers and Field Instruments:
  - 1. Provide on-site operation and maintenance training by Control System Integrator and the equipment manufacturer representatives prior to placing the equipment in continuous operation. The services of equipment manufacturer's representatives shall be provided for a minimum of two hours for each type of instrument provided.
  - 2. Training shall accomplish the following:
    - a. Provide instruction covering use and operation of the equipment to perform the intended functions.
    - b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment calibration.
    - c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant control system.

**END OF SECTION**



**SECTION 40 61 93**  
**CONTROL SYSTEM INPUT/OUTPUT LIST**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Input-Output lists.
- B. System Requirements
  - 1. Provide and install the hardware required for the monitoring and control of the Input/Output subsystem.
- C. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.
  - 3. Section 40 05 92 - General Control Panel Requirements for Pumping Systems
  - 4. Section 40 61 96 - Control System Configuration

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. Input/Output (I/O) List Submittal
  - 1. Submit a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
  - 2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
  - 3. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8 1/2 inch by 11 inch hard copy.
  - 4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O as required in the specifications.
  - 5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet shall include the following information:
    - a. TAG NUMBER(S): As indicated on the drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
    - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
    - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is

- wired to.
- d. Physical POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
  - e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
  - f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
  - g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
  - h. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
  - i. P&ID – the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
6. The I/O list shall be sorted in order by:
    - a. Physical location
    - b. I/O Type
    - c. Loop Number
    - d. Device Tag
  7. Once the I/O list is approved, the PLC I/O addresses shall not be modified without approval by the ENGINEER.

1.5 QUALITY ASSURANCE - NOT USED

1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

1.7 SITE CONDITIONS - NOT USED

1.8 WARRANTY - NOT USED

## PART 2 - PRODUCTS

### 2.1 INPUT/OUTPUT LIST REQUIREMENTS

- A. The Input/Output list shall contain all items to be configuration items of the point and shall be capable of being imported and exported into the system via an Excel spread sheet.

## PART 3 - EXECUTION

### 3.1 INPUT/OUTPUT LIST

- A. The preliminary Input/Output list is provided in the Contract Drawings.

**END OF SECTION**

**SECTION 40 61 96  
CONTROL SYSTEM CONFIGURATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Provide and install instrumentation system for monitoring and control of the lift station control system as described herein, and as indicated on the Plans.
- B. All Universal Pump Controllers (UPCs) shall be pre-programmed from the factory for lift station pump down control. Refer to Section 40 05 92 for more information.
- C. Hardware components, equipment, and related items for the instrumentation system shall be as indicated on the Plans and Specifications.
- D. Monitoring and control of various functions of this plant comprise of control narratives as described in this Section, with a description of instruments and related items given in other sections of the specifications and as shown on the drawings. The following description is brief for the purpose of understanding the control philosophy only. Important loops have been described; for the remaining loops, refer to plans and other sections of the Specifications.
- E. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements
  - 1. Comply with the submittal requirements of Section 01 31 00 - Project Management and Coordination, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
  - 2. Submittals require information on related programming to be furnished under this Section. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.
  - 3. Control Strategy shall be submitted for each individual remote site with related Logic Flow Chart fully indicating all logic steps as defined herein and as required to fully implement all functionality as described in the contract documents.
  - 4. Each logic chart shall have descriptions associated to fully describe its use. Custom functions or control blocks created and or utilized shall be fully documented complete with a logic flow chart. This shall include but not limited to PLC Defined Function Blocks (DFB).
- B. Submittal Content
  - 1. The Control System Integrator shall create shop drawings, including all logic flow charts and diagrams, in the Control System Integrator's Engineering Department. All shop drawings shall bear the Control System Integrator's logo, drawing file numbers,

and shall be maintained on file in the Control System Integrator's archive file system. Photocopies or electronically created copies of the ENGINEER's Diagrams or specifications are unacceptable as shop drawings and shall be returned un-reviewed.

C. Required Submittals

1. All work described herein shall be incorporated into a work plan submittal as defined in Related Work sections.
2. Shop Drawings
  - a. Shop Drawings shall include the following:
    - 1) Logic Flow Charts or Diagrams shall be submitted with control strategy for each individual remote site. The diagrams shall indicate sufficient detail to be clearly understood by the OWNER's representative and include I/O tag names for all data as submitted within the memory maps as specified herein.
    - 2) A Communication Memory Map shall be submitted and include specific Tag Names, Data type, expected range, and register. A separate map for any data concentrator and PLC for each remote site shall be submitted, if applicable. These Maps shall fully document all communications in and out of the remote site and these communications shall be as further defined herein.
  - b. Data Communications Interconnecting Diagrams
    - 1) Provide interconnecting diagrams showing Data connections between equipment and include the Requester and the rate at which the data will be transmitted.
3. Factory Tests.
  - a. Submittals shall be per testing as specified in Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
4. Site Tests and Commissioning.
  - a. Submittals shall be per testing and commissioning as specified in Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
5. Operation and Maintenance Manuals.
  - a. Operation and maintenance manuals shall be as specified in Section 40 61 00 - Instrumentation and Control System General Provisions.

1.5 QUALITY ASSURANCE - NOT USED

1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

1.7 SITE CONDITIONS - NOT USED

1.8 WARRANTY - NOT USED

PART 2 - PRODUCTS

2.1 DEVELOPMENT OF CONTROL STRATEGY

A. General

1. Control Strategies and Process Instrumentation Diagrams (PIDs) have been developed by the ENGINEER. These briefs and PIDs outline the basic requirements for controlling the process. The guidelines will be utilized on the project, but they do not outline the detail control requirements or understanding of the process automation. These Control Strategies will need to be developed further and a mutual understanding of the control process will need to be agreed upon by the ENGINEER, Control System Integrator, and

the OWNER. The following workshops will be held;

## 2.2 PROGRAMMING/CONFIGURATION REQUIREMENTS

### A. General Requirements

1. All UPC programming and configuration shall be performed in accordance with control narratives and Section 40 05 92. All calculations, totalizations, lead/log control and sequencing needed for the PLC programs shall be accomplished at the UPC's logic level.
2. The UPC shall be pre-programmed from the factory for direct interface with the integral HMI including all latching, unlatching, and other functions.
3. All analog I/O points and related values shall be scaled within the UPC, to an IEEE 32-bit floating point value and displayed at the HMI systems.

### B. Alarms

1. Refer to the UPC manufacturer's information for all pre-programmed alarms available.

### C. PLC to HMI Interface

1. All calculations, totalizations, lead/log control and sequencing needed for the PLC programs shall be accomplished at the PLC level.
2. All field analog scaling is to be accomplished in the PLC programming. The final value shall be an unsigned integer, displayed from the HMI .
3. All request commands such as "OPEN", "CLOSE", "START", "STOP", "AUTO" and "MANUAL" sent by the HMI will be reset in the PLC. The PLC program will provide the latching logic to accomplish the HMI request. The PLC shall latch all commands and not un-latch that command until received from the PLC or until an alarm causes an action by that equipment.
4. All time synchronization logic, PLC heartbeats, shall be performed at the PLC level. Other PLC health status such as I/O, PLC Run, Halt, Failure, low battery, etc. shall be read from the PLC.

### D. PID

1. All tuning parameters for each PID shall be available for monitoring and adjustment. The tuning parameters shall be viewable by all, but changeable only by the people with appropriate security. Tuning trends shall be provided to monitor the PID functions.
2. A method of bumpless transfer shall be implemented in the PLC programs to prevent unwanted process interruptions during operational transitions from "MANUAL-to-AUTO", and "AUTO-to-MANUAL" modes.

### E. Equipment Runtimes

1. Each piece of monitored equipment shall be provided with 2 separate runtime calculations. Based upon security privileges, the operator will be allowed to reset 1 of the runtimes after the piece of equipment has been serviced. The second runtime will continue until reset by plant personnel with the appropriate security level. Both runtimes shall be displayed via the process graphic screen. Runtimes shall be displayed in hours in "XXXXXX.X" format with .X = 6 minutes.

### F. Totalizers

1. The PLC shall be implemented with double precision real counters to accumulate flows. The PLC scan time shall not affect the accumulation accuracy more the 0.5%. All calculations shall be performed in the PLC, and the totalized value in engineering units shall be stored locally in the PLC. The PLC shall reset the totalized values each day at midnight, via the PLC clock. When the PLC clock reaches midnight, the current day

total will be stored as the previous day's total, and the current day total will be reset to zero.

2. Do not totalize if the analog signal is outside the 4-20 mA range. Each flow totalization shall come with a reset button on the HMI screen. Do not totalize if the value of the flow input is less than 2% of the full range of the input.

#### G. Time and Timer Values

1. Time and Timer Values will be sent and received via the HMI as integers. All conversion will be handled in the PLC. Time will be broken into fields such as: Hours, Minutes and Seconds. Three separated HMI tags shall be used.

#### H. Control Modes

1. Computer (Remote) Manual: In this mode, all automatic functions associated with a specific control loop are disabled except for safety interlocks and alarms. Provisions shall be provided to allow Operations staff to access the following functions from the HMI:
  - a. Start and Stop Motors
  - b. Adjust Variable Motor Speeds.
  - c. The following list summarizes the safety monitoring and control features active in this mode:
    - 1) Permissives (Conditions that must be met for a machine to begin operation)
      - a) Field equipment HOA Switch must be in "AUTO" position.
      - b) Computer Mode (software switch) must be in "MANUAL".
    - 2) Interlocks (Conditions that must be met for a machine to begin or continue operation)
      - a) No active alarms.
      - b) Additional interlocks are dependent on each individual loop. See individual loop descriptions below.
    - 3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
      - a) Fail To Operate (Open, Close, Start, Stop, Discrepancy, etc.).
      - b) Additional alarms are dependent on each individual loop. See individual loop descriptions below.
2. Computer (Remote) Auto: In this mode, all automatic functions associated with a specific control loop are controlled by the PLC/RTU automatic logic. Operations staff can only adjust the following functions from the HMI:
  - a. Control Mode.
  - b. PID Loop Setpoints (Level Setpoints, Timer Values, etc.).
  - c. Pump Lead/Lag Settings.
  - d. The following list summarizes the safety monitoring and control features active in this mode:
    - 1) Permissives (Conditions that must be met for a machine to begin operation)
      - a) HOA Switch must be in "AUTO" position
      - b) Computer Mode (software switch) must be in "AUTOMATIC".
    - 2) Interlocks (Conditions that must be met in order for a machine to begin or continue operation)
      - a) No active alarms
      - b) Additional interlocks are dependent on each individual loop. See individual loop descriptions below.

- 3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
  - a) Fail to Operate (Open, Close, Start, Stop, etc.).
  - b) Additional alarms are dependent on each individual loop. See loop individual descriptions below.
- 3. Local Manual: This mode is available only with those pieces of equipment (motors, valves, etc.) that have an HOA, LOR, or similar switch. In this mode, all remote control (remote manual or remote auto) functions associated with that piece of equipment are disabled, including any PLC-based safety Permissives. Operations staff can set or adjust the following functions from the local control devices (e.g. pushbuttons, hand switch, etc.):
  - a. Start and Stop Motors
  - b. Adjust Variable Motor Speeds
  - c. The following list summarizes the safety monitoring and control features active in this mode:
    - 1) Permissives (Conditions that must be met for a machine to begin operation)
      - a) HOA Switch must be in HAND position
    - 2) Interlocks (Conditions that must be met in order for a machine to begin or continue operation)
      - a) Additional interlocks are dependent hardwired points associated with each individual loop. See individual loop descriptions below.
    - 3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
      - a) Fail to Operate (Open, Close, Start, Stop, etc.) are disabled.
      - b) "UNAVAILABLE" shall be displayed in the HMI when a piece of monitored equipment is not in AUTO.
      - c) Additional alarms are dependent on each individual loop and may still be active in the HMI. See loop individual descriptions below.
  - d. Motor control programming in the PLC shall incorporate bump-less transfer such that switching the motor controller HOA (or LOR) switch from "HAND" (or "LOCAL") to "AUTO" (or "REMOTE") results in a smooth transition without upset to running status or speed.

## 2.3 HUMAN MACHINE INTERFACE (HMI)

### A. General

- 1. The graphics included with the pre-programmed UPCs shall not require modification. Refer to the UPC manufacturer's information for details on the HMI graphics.

## 2.4 OPERATION AND CONTROL STRATEGIES

### A. General

- 1. The UPC shall be pre-programmed for lift station pump down configuration for a total of 4 pumps.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Deliver, handle and store control system components in accordance with manufacturer's written instructions and the requirements of Section 01 60 00 - Product Requirements.
- B. Specific requirement for the control system:

1. Computer and network equipment shall not be placed into service until the room or building is fully enclosed and has functional HVAC equipment.

### 3.2 TESTING, COMMISSIONING AND TRAINING

- A. Testing and Commissioning: Accomplished in accordance with the requirements of Section 01 70 00 - Execution Requirements and Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
- B. Training: Accomplished in accordance with the requirements of Section 40 61 26 - Instrumentation and Control System Training and Section 01 70 00 - Execution Requirements.

**END OF SECTION**



**SECTION 40 63 93**  
**CELLULAR-WEB BASED MONITORING SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section of the Specifications describes the requirements for a cellular radio and a third-party hosted web based monitoring software and alarm call-outs.
- B. Each remote terminal unit (RTU) includes the necessary hardware for installation, including cellular radio, enclosure, backup battery, transformer, antenna with cable and mounting hardware.
- C. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.
- D. Provide equipment, materials, software, calibrations, training, and services required to successfully interface and interconnect the system and associated equipment that are specified or designated in drawings or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.
- E. Furnish startup, training, and system check out services.
- F. Furnish and install all items obviously necessary for the proper functioning of the equipment even if omitted at no additional cost to the OWNER.
- G. The Contract Documents Supplement this Section and provide additional details showing panel elevations, functional requirements of the system, and interaction with other equipment.
- H. Coordinate and schedule all testing procedures with the OWNER/ENGINEER.
- I. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

**1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements: Comply with the submittal requirements of Section 01 31 00 - Project Management and Coordination, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
- B. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.
- C. Submit catalog data for all items supplied from this specification Section as applicable.

Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

- D. Submit a bill of materials for each PLC clearly identifying all components and quantities.
- E. Submit catalog data sheets for all software licenses provided under this Specification Section.
- F. Operation and Maintenance Manuals.
  - 1. Operation and Maintenance manuals shall include the following information:
    - a. Manufacturer's contact address and telephone number for parts and service.
    - b. Instruction books and/or leaflets
    - c. Recommended renewal parts list
    - d. Record Documents for the information required by the Submittals above.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Five years' experience in the design, manufacture and installation of this type of system.

#### 1.6 DELIVERY, STORAGE, AND HANDLING - NOT USED

#### 1.7 SITE CONDITIONS - NOT USED

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the control system that fail(s) in materials or workmanship within the specified warranty period.
  - 1. Warranty Period: Two (2) years from the date of completion of the Site Acceptance Test.
  - 2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty, as well as replacement of defective work.

#### 1.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to OWNER to allow scheduling and access to system and to allow OWNER to upgrade computer equipment if necessary.
  - 2. Miscellaneous components (including cables): Provide spares for each unique component installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, have been named within the various paragraphs of this Section.
  - 1. Mission Communications, MyDro 850

### 2.2 REMOTE TERMINAL UNIT

- A. Enclosure shall be NEMA 4X, fiberglass reinforced polyester with poured polyurethane gasket.
- B. Hardware shall be 300 series stainless steel and shall be provided with a padlock latch.
- C. Back panel shall be aluminum.
- D. Input/Outputs:
  - 1. Sixteen (16) supervised digital inputs; first eight (3) changeable to run time/start accumulators and three (3) additional digital inputs built-in (AC and battery fail, input wiring fault).
  - 2. Two (2) Analog Inputs: 0-5 VDC, 4-20mA, 10-bit resolution, 4 alarm set points per input.
  - 3. Two (2) pulse counter inputs.
  - 4. One (1) electronic key reader.
- E. Power Supply shall be supervised 120VAC to 12VDC, 1.2 amp
- F. Battery shall be 12V, %AH batter standard, with enchased charging system.
- G. Radio units automatically self-enroll, GSM radios using data transmission protocol, 0.6 to 2 watt maximum transmit power and -112dba sensitivity.
- H. Antenna shall be a remote pole mount 3 db gain omni-directional antenna with 50' low loss.
- I. Cellular Service Contract: Provide a 2-year cellular service contract.

### 2.3 WEB BASED MONITORING SYSTEM

- A. System shall be capability of providing real-time alarms via phone call, text message, and email. Set-up shall be menu driven alarm call-out schedule. Each alarm shall be logged with time stamp for tracking and reporting.
- B. System shall be capable of totaling pump run times and pump starts.
- C. System shall be capable of reporting analog values every two minutes or on 5% change.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install the programmable logic controllers in accordance with the manufacturer's instructions, the shop drawings, the Drawings, and the requirements of Section 01 40 00 - Quality Requirements.

### 3.2 TESTING, COMMISSIONING, AND TRAINING

- A. Testing and Commissioning: Accomplished in accordance with the requirements of Section 01 70 00 - Execution Requirements and Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.
- B. Training: Accomplished in accordance with the requirements of Section 40 61 26 - Instrumentation and Control System Training and Section 01 70 00 - Execution Requirements.

**END OF SECTION**

**SECTION 40 67 00**  
**CONTROL SYSTEM PANELS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

**A. Section Summary:**

1. Furnish and install fully functional control panels to manually and automatically operate control systems as specified in the detailed requirements of the instrumentation sections of Division 40 and supplemented with logic and schematics diagrams as shown on the Electrical and Instrumentation Drawings.
2. It is the intent of these specifications to have all I/O and signal conditioning components included within their respective control panels. The panel sizes shown on the Contract Documents shall be considered minimum. The Control System Integrator shall be responsible for final sizing of enclosures to meet the clearance requirements of NFPA 70 and NFPA 79 and as specified herein. Should the Control System Integrator submit a panel size and layout that is, in the opinion of the OWNER and or ENGINEER, insufficient in size to meet these requirements, the submittal will not be approved and will be returned for revision and resubmission. The Control System Integrator shall be required to revise the panel size and layout and resubmit for approval at no additional cost to the OWNER.
3. All enclosures and panel components shall be of the same manufacture wherever possible.
4. Installation and configuration of network infrastructure cabling and equipment shall be a cooperative and coordinated effort between OWNER, the CONTRACTOR, and the Control System Integrator. The Control System Integrator shall furnish all labor necessary for the installation and testing as required to fully meet the applicable specifications of this equipment.
5. All field instruments and equipment shall be retagged with tag names per the I/O list provided. Retag all existing field instrumentation and equipment using stainless steel plates with new tag names engraved, if applicable.
6. All Control System Panels shall have a UL 508A label affix to the inside of the panel.

**B. Related Sections include but are not necessarily limited to:**

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 40 61 00 - Instrumentation and Control System General Provisions
4. Section 40 63 43 - Programmable Logic Controllers (PLCs)
5. Section 40 66 00 - Control System Network Communication Equipment
6. Section 40 61 93 - Control System Input/Output List

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.**

### 1.3 ADMINISTRATIVE REQUIREMENTS - NOT USED

### 1.4 SUBMITTALS

- A. Comply with the submittal requirements of Section 01 31 00 - Project Management and Coordination, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
- B. Product Data:
  - 1. Bill of Materials
    - a. Specific information identifying model numbers for all proposed items and any optional product features included.
    - b. Equipment and other components shall be grouped according to each associated facility/panel system to be provided.
  - 2. Catalog Cuts: Instrument and control components, electrical devices, and software systems:
    - a. Catalog information, mark to identify proposed items and optional product features.
    - b. Descriptive literature.
    - c. External power and signal connections.
    - d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
    - e. Test reports.
  - 3. Component Data Sheets: Data sheets for instrument and control components.
    - a. Isolate component type identification type identification code and tag number on data sheet.
    - b. Specific features and configuration data for each component:
      - 1) Location or service.
      - 2) manufacturer and complete model number.
      - 3) Size and scale range.
      - 4) Set points.
      - 5) Materials of construction.
      - 6) Options included.
      - 7) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
- C. Panel Layout Drawings and Wiring Diagrams Submittal
  - 1. Where direct hardwired interfaces exist between the PLC panels and vendor provided control panels furnished under other Divisions, the CONTRACTOR shall provide to the Control System Integrator the approved submittals in order for the Control System Integrator to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings shall be included in the Final O&M submittal. Leaving this information blank on the Final Documentation drawings is not acceptable.

2. Panel Layout Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11x17 inches in size. At a minimum, the panel drawings shall include the following:
  - a. Interior and exterior panel elevation drawings to scale.
  - b. Nameplate schedule.
  - c. Conduit access locations.
  - d. Panel construction details.
  - e. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
  - f. Fabrication and painting specifications including color (or color samples).
  - g. Construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
  - h. For every control panel, heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
  - i. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Control System Integrator.
3. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. If Loop Wiring Diagrams are specified below, equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device tag and a unique numeric identifier. The diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the Control System Integrator. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the Control System Integrator and approved by the ENGINEER. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and 4-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11x17 inches in size.
4. ISA Loop Wiring Diagrams: Individual wiring diagram for each field device or instrument shall be required. Loop diagrams shall comply with the minimum requirements of ISA S5.4. Drawings shall be 11x17-inch sheet for each device. Divide

loop diagram into areas for panel face, back-of-panel, and field. Show the terminal numbers, location of dc power supply, switching contacts in analog loops and output contacts of analog devices. Show circuit and raceway schedule names and terminal numbers. Drawing shall show electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted instruments. Component and panel terminal board identification numbers and external wire and cable numbers. Circuit names matching Circuit and Raceway Schedule. Intermediate terminations between field elements and panels to terminal junction boxes and pull boxes. Diagrams show bear Subcontractor signature attesting diagrams have been coordinated with electrical drawings.

D. Operation and Maintenance Data:

1. In accordance with Section 01 31 00 - Project Management and Coordination, and as specified in this Section.
2. Final As-Built drawing shall be supplied in AutoCAD format for use by the OWNER in modifying panels for future expansion or required modifications.

1.5 QUALITY ASSURANCE

A. Installer's Qualifications

1. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

1.6 DELIVERY STORAGE AND HANDLING

- A. Completed control panels and related equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the general CONTRACTOR, the OWNER and ENGINEER.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped with each panel.
- C. Visible shipping damage to any portion of a shipment shall be assumed to have also damaged the surrounding portion. The visibly damaged and the surrounding panels shall be returned to the manufacturer's UL 508 facility, for examination and damaged equipment replaced, followed by a Witnessed Test of the returned portion, as specified in Section 40 61 21 - Instrumentation and Control System Testing and Commissioning, at no expense to the OWNER or ENGINEER.
- D. Control Panels shall be installed in their permanent finished location shown on the drawings within 7 calendar days of arriving onsite. If the equipment cannot be installed within 7 calendar days, the equipment shall not be delivered to the site, but stored offsite, at the CONTRACTOR's expense, until such time that the site is ready for permanent installation of the equipment.
- E. Space heaters shall be furnished in control panels and the CONTRACTOR shall provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.7 SITE CONDITIONS - NOT USED



## 1.8 WARRANTY

- A. Special Warranty: manufacturer's standard form in which manufacturer agrees to repair or replace components of the Control System that fail(s) in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
  - 2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in warranty, as well as replacement of defective work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, have been named within the various paragraphs of this Section.
- B. The listing of specific manufacturers within the various paragraphs of this Section does not imply acceptance of their products that do not meet the specified ratings, features and functions. manufacturers listed within the various paragraphs of this Section are not relieved from meeting these specifications in their entirety.

### 2.2 GENERAL REQUIREMENTS

- A. The dimensions shown on the Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.
- B. The devices designated for rear-of-panel mounting shall be arranged within the panel in a manner to allow for ease of maintenance and adjustment. Heat generating devices such as power supplies shall be located at or near the top of the panel.
- C. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with manufacturer's recommendations. The internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and Control System Integrator's data.
- D. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.
- E. Each panel shall be supplied with separate 120 Vac distribution circuit breakers for the incoming service, enclosure light, enclosure heater, enclosure ac unit, service receptacle, 24 Vdc supply/UPS and a common breaker feeding fuse blocks for the field instruments. Provide fuses for each instrument powered from panel.
- F. Each panel, where 24 Vdc power is required shall be furnished with a combination 24 Vdc power supply and UPS. UPS shall be sized to supply power for 24 Vdc power circuits for

10 min.

G. PLC I/O Wiring and Device Requirements:

1. Discrete Input and Output Wiring: Provide a fuse per common group. Each discrete input/output and each spare discrete input/output shall be furnished with an interposing relay hardwired to the feed through terminal as well. For those digital outputs energizing lights, horns, solenoids, etc. shall utilize a "miniature" type relay.
2. Analog Input and Output Wiring: Provide a fuse for each analog signal. Each analog input/output and each spare analog input/output shall be furnished with a surge protection device hardwired to the fed through terminal block.
3. All spare PLC points shall be wired to required interposing relay or surge protection device.

H. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.

I. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to 3 lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32-inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black against a White background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless steel screws for cabinet mounted nameplates
4. For every panel, provide a panel nameplate with a minimum of 1 inch high letters. Provide legend plates or 1x3 inches engraved nameplates with 1/4 inch lettering for identification of door mounted control devices, pilot lights, and meters.
5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.

## 2.3 PANEL REQUIREMENTS

A. Structure and Enclosure

1. Panels shall be of continuous welded-steel. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.
2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a 3-point stainless steel latch and heavy-duty stainless-steel locking handle. Rear access doors (if included) shall be conveniently

arranged and sized such that they extend no further than 24 inches beyond the panel when opened to the 90-degree position. Front and side access doors shall be as shown. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.

3. The panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends, and shall be routed for easy access to other components for maintenance and inspection purposes.
  4. The panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal 1-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.
  5. All panels in indoor environmentally-controlled environments (air conditioned) shall be NEMA 12 unless otherwise noted. All panels installed indoors, in non-environmental controlled environments or panels installed in outdoor, wet, and chemically corrosive environments shall be NEMA 4X unless otherwise noted. All panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).
  6. Panels installed outdoors shall have an additional requirement of white polyester paint factory applied from the manufacturer.
- B. Freestanding and Floor-Mounted Vertical Panels
1. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12 gauge sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated panels shall be constructed of Type 304 stainless steel, unless FRP is specifically indicated to be provided. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.
- C. Wall and Support Channel Mounted Panels
1. All wall and support channel mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14 gauge steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of Type 304 stainless steel, unless otherwise is specifically indicated.
- D. Finish Requirements
1. All sections shall be descaled, degreased, filled, ground, and finished. The enclosure when fabricated of steel shall be finished with 2 rust-resistant phosphate prime coats and 2 coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum panels will not require a paint finish.
  2. The panels shall have edges ground smooth and shall be sandblasted and then

- cleaned with a solvent. Surface voids shall be filled and ground smooth.
3. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a 2-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.
  4. Apply a minimum of 2 coats of manufacturer's standard, flat light-colored lacquer on the panel interior after priming.
  5. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish.
  6. NEMA 4X Stainless Steel panels installed outdoors shall have an additional requirement of white polyester powder coated paint, factory applied from the manufacturer.
- E. Print storage pockets shall be provided on the inside of each panel. The storage pockets shall be steel, welded on to the door, and finished to match the interior panel color. The storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5x11 inch documents without folding.
- F. Folding shelf shall be provided on the inside of the door on all free-standing and floor-mounted panels. The shelf shall be suitable for a laptop computer and shall be placed such that an open laptop computer does not interfere with any door-mounted devices. The folded shelf shall not interfere with any internal panel components when the door is closed. The folding shelf shall automatically lock in the horizontal position when raised. The folding shelf shall be approximately 18 inches wide by 12 inches deep and shall have a minimum distributed load rating of 100 lb. All parts shall be made of heavy gauge steel and shall be painted white or finished to match the interior panel color.
- G. Condensation Control
1. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned space.
    - a. Enclosure heaters shall be energized from 120 V, single-phase power supply and sized to prevent condensation within the enclosure.
    - b. Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
    - c. Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40°F-90°F. Provide a circuit breaker or fused disconnect switch within the enclosure.
    - d. Enclosure heaters shall be Hoffman type DAH or equal.
  2. Strip heaters may be provided if they are 240 V rated, powered at 120 Vac and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox or equal.
    - a. Strip heaters shall be Chromalox, Type OT, 1.5 inches wide, 240 Vac, single phase, 150 W, energized at 120 Vac, with rust-resisting iron sheath, Catalog No. OT-715, Product Code No. 129314, or equal. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the

enclosure drop below the dew point.

- b. A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No .263177, or equal.
  - c. The strip heater terminals shall be guarded by a protective terminal cover.
  - d. High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, Product Code No. 263783, or equal.
3. Each panel shall have a 1/2 inch stainless steel condensate drain, installed on a stainless steel conduit hub, HGTZ Series, T&B or equal, in the bottom of the enclosure. Drain shall be O-Z Gedney DBB-50SS, or equal.

#### H. Panel Interior Ambient Control

1. The manufacturer shall provide ambient temperature control within the panel to maintain internal temperatures below the maximum operating temperatures of the panel components. An ambient temperature range of -20°C to 40°C.
2. The manufacturer shall provide panel internal heat rise calculations to show that the panel internal temperatures will be maintained below the maximum operating temperatures of the panel components.
3. The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in °C above the specified ambient, If the specified temperature range cannot be met, an air conditioning system shall be provided with sufficient capacity to maintain the temperature within the specified limits. Panels for which the calculated heat rise exceeds 40°C shall have an air conditioning system sized-as-required to reduce the heat rise to 40°C or less, without violating the NEMA rating of the enclosure.
4. The air conditioner shall have the following features:
  - a. Use CFC-free R134a refrigerant.
  - b. Have fully gasketed flanges on all 4 mounting edges for a watertight seal that maintains NEMA 4X rating of the panel.
  - c. Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.
  - d. EMI/RFI suppressor to minimize transient spikes during compressor on-off cycling.
  - e. Separated blower-driven evaporator and condenser air systems for closed loop cooling.
  - f. UL listed.
  - g. Stainless steel enclosure.
  - h. Internal corrosion resistant coating.
  - i. Low ambient kit.
  - j. Short cycle protector.
  - k. The air conditioning unit shall be Hoffman, Thermo Electric or approved equal.

## 2.4 CORROSION CONTROL

- A. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model AHCI; or equal.

## 2.5 PANEL MOUNTED CONTROL OR INDICATING DEVICES

### A. Combined Sounder and LED Beacon

- 1. Where indicated panels shall be provided with a "Combined Sounder and LED Beacon". The combined sounder and flashing LED beacon shall have polycarbonate housing and lens, 45 mm size, 22 mm mounting hole, and Type 4X. Control logic shall be provided so that the unit can be silenced, until alarm is cleared and reset. The sounder shall have average 103 dBA at 1 m and shall be configured as pulsing. The combined sounder and flashing LED beacon shall be as manufactured by Eaton, Model RoLP Maxi Solista; or equal.

### B. Pilot Devices

- 1. Push Buttons, Selector Switches and Pilot Lights
  - a. Push buttons, Type 4/4X/13 corrosion-resistant/watertight/oiltight plastic, selector switches and pilot lights shall be 30.5 mm type.
  - b. Push buttons, selector switches and pilot lights shall have electrical ratings of:
    - 1) Dielectric strength – 2,200 V for 1 min.
    - 2) Electrical design life cycles – 10,000,000 at maximum rated load
  - c. Push buttons, selector switches and pilot lights shall have an operating range of -40-131°F (-40-55°C).
  - d. Illuminated devices shall offer universal LED that accepts 12-130 Vac/Vdc voltage input. Lens color shall be as follows;
    - 1) Running, on, open – “RED”.
    - 2) Stopped, off, closed – “GREEN”.
    - 3) Alarm – “AMBER”.
    - 4) Power on – “WHITE”.
    - 5) Blue - All other status indications not covered by the above
    - 6) Lens caps shall be approximately 0.46 inch diameter. Provide legend faceplates engraved to indicate the required function of each device; NEMA rating: 4X.
  - e. Push buttons shall have a diaphragm seal for protection from liquids, particles and corrosive agents. Button colors shall be as follows;
    - 1) Start, open – “RED”.
    - 2) Stop, close – “GREEN”.
    - 3) All other status indications not covered by the above – “BLACK”.
  - f. Selector switches shall incorporate a positive detent to prevent the switch from hanging up between positions.
    - 1) Selector switches shall incorporate a positive detent to prevent the switch from hanging up between positions.
- 2. Potentiometer Devices

- a. Potentiometer devices shall be Type 4/4X/13 corrosion-resistant/watertight/oiltight plastic, 30.5mm type.
  - b. Potentiometer devices shall be rated for 300 Vac/Vdc, 2 W maximum (6 Vdc minimum):
    - 1) Mechanical design life – Min. 25,000 cycles
    - 2) Rotational torque – 3-12 in/oz
    - 3) Stopping torque – Min. 12 in/lb
  - c. Potentiometer devices shall have single-turn operation, 312 degree rotation.
  - d. Potentiometer devices shall be finger-safe.
3. Elapsed Time Meters
- a. Meter shall be heavy duty, electro-mechanical, non-resettable, 6 digit 99999.9h Unit shall be NEMA 4X rated.
  - b. Mounting of unit with gasket shall maintain rating of enclosure.
- C. Digital Panel Meter
- 1. Meter shall be electronic, 3.5 digit, 0.56 inch high efficiency LED display and shall provide indicated in engineering units of measured variable. Case type shall be watertight and dust-tight (NEMA 4X).

## 2.6 CONTROL PANEL - INTERNAL CONSTRUCTION

- A. Panel lighting
- 1. Panels shall be provided with a door switch activated 24 Vdc LED light.
- B. Panel Service Receptacle
- 1. Panels shall be provided with a DIN Rail Mounted straight blade, 125 Vac, 15 Amp, non-feed-through type receptacle. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include LED status indicator light.
- C. Panel Incoming Surge Protection
- 1. Provide modular, pluggable surge protective device of the incoming power feed to the control panel. Units shall be metal oxide varistors (MOVs) and gas-filled surge arresters, with a maximum continuous operating voltage of 150 Vac.
- D. Circuit Breakers
- 1. Breakers shall be thermal-magnetic, current-limiting type, UL Listed, 10 kA.
  - 2. Housing shall satisfy Insulation Group II/RAL 7035, shall have IP20 finger-safe design, shall be suitable for DIN rail mounting and shall include status indicator window and scratch- and solvent-resistant printing
- E. 24 Vdc Power Supplies
- 1. Provide a 24 Vdc power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on-off circuit breaker. Size the 24 Vdc power supply to accommodate the design load plus a minimum 50% spare capacity. Power supply shall be primary switched, DIN Rail mounted, with LED indication and status contacts. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

Mount the 24 Vdc power supply such that dissipated heat does not adversely affect other panel components.

F. 120 Vac Uninterruptible Power Supply (UPS)

1. Provide a 120 Vac UPS in the control panel to power control components, including PLC, relays, 24 Vdc power supplies, etc. as required. Equip the power supply with a power on-off circuit breaker. Size the UPS to accommodate the design load plus a minimum 50% spare capacity, with 10-minute battery life at full load. UPS shall be DIN Rail mounted, with LED indication and status contacts. Mount the UPS power supply such that dissipated heat does not adversely affect other panel components. Provide a maintenance bypass switch to allow the UPS to be taken out of service for maintenance or replacement.

G. Fuse Blocks

1. Fuse Blocks shall be DIN Rail mounted, single level, standard size, set screw terminal, with blown fuse indicator.

H. Terminal Blocks – 120 Vac or 24 Vdc

1. Terminal blocks shall be DIN-Rail mounted, IEC screw-type, feed-through, single level, rated IP20. Metal components shall be made of corrosion resistant materials. The metal body shall contain a serrated pressure plate that will provide a gas-tight connection with the conductor. Terminal Blocks shall have captive screws. Control terminal blocks shall have a snap-in card marking system. Marking shall be computer generated.

I. Relays

1. Relays – Time Delay

- a. Relays shall mount on tube-type bases with pin-style socket mounting. Shall have 10 Amp, B300, DPDT contact ratings and coil voltages as shown on drawings and adjustable timing ranges.

2. Relays – General Purpose

- a. Relays shall have tube-base/Octal 8-pin or 11-pin terminals and “ON-OFF” flag indicators. Contacts shall be silver nickel and have 10 Amp, B300, DPDT or 3PDT ratings. Shall have an electrical schematic on the faceplate, a clear cover for visual inspection and snap-in marker ability. Relays shall have LED status indicators, push-to-test and manual override.

3. Relays – Miniature

- a. Relays shall be square-base, 4-pole, plug-in type with blade-style terminals and “ON-OFF” flag indicators. Contacts shall be silver nickel and have 7 Amp or 10 Amp, DPDT or 4PDT ratings. Shall have an electrical schematic on the faceplate and a clear cover for visual inspection and LED status indicators and push-to-test button with incorporated manual override lever.

4. Relays - PLC Interposing

- a. Relays shall be DIN Rail Mount, screw terminal, slim factor design. Shall be pluggable, with ejector feature. Contacts shall be silver nickel and have 5 Amp, 24 Vdc or 3 A, 120 Vac, SPDT electro-mechanical and shall have LED status indicators.



- 5. Timers – Solid-State
  - a. Timers shall be DIN rail-mounted. Contacts shall be available as SPDT or DPDT, 8 A. Timers shall be available with On-Delay, Off-Delay, On-Delay and Off-Delay, One-Shot, and Flasher operating modes as required on the drawings. Timers shall have coil surge protection and adjustable timing ranges of 0.05 sec. to 60 hours as shown on drawings.
- 6. Timers – Programmable
  - a. Timers shall be digital timing relays with LCD display and shall be socket or panel mounted. Contacts shall be SPDT, rated 5 Amp, B300. Timers shall be configurable for Signal On-Delay, Power On-Delay, Off-Delay, Repeat Cycle, One-Shot and Cumulative operating modes as required on the drawings. Timers shall have timing ranges of 0.000 sec. to 9999 hours, depending on selected mode and as shown on drawings.
- J. Analog Signal Surge Protection
  - 1. Analog signal surge protection shall be slim-factor hybrid design that combines solid-state electronic and gas filled discharge tube to provide protection to 20 kA.
- K. Signal Isolators
  - 1. Signal Isolators shall be DIN Rail mounted, solid state, ASIC technology; electronic type, with 0.15 accuracy. There shall be complete isolation between input circuitry, output circuitry, and the power supply. Zero and span adjustment shall be provided. Units shall be as manufactured by Action Instruments, Model Slim Pak; or approved equal.
- L. Fiber Optic Patch Panel
  - 1. Provide DIN rail mounted patch panels with at locations shown to terminate cabling from the network elements. Physical locations and number of SC connectors supported shall be sufficient to terminate all fibers at each fiber drop point.
- M. CAT 6 Patch Pane:
  - 1. Provide DIN rail mounted patch panels with at locations shown to terminate cabling from the network elements. Performance parameters, including NEXT, Attenuation and Return Loss shall meet Category 6E Cabling Standard.

## 2.7 INTERNAL ELECTRICAL WIRING REQUIREMENTS

- A. All interconnecting wiring shall be stranded, type MTW, and shall have 600 V insulation and be rated for not less than 90°C. Wiring for systems operating at voltages in excess of 120 Vac shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 Vac and lower voltage wiring systems without direct exposure to higher voltages.
- B. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 18 AWG shielded, twisted pair, cable insulated for not less than 600 Vac.
- C. Power and low voltage dc wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each

other shall be separated by at least 6 inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60% visible fill.

D. Terminations

1. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable. Wiring for input/output points for the PLC shall be allowed to terminate directly to interposing relay or surge protector.
2. Multi-level terminal blocks or strips are not acceptable.
3. Terminal blocks shall be arranged in vertical rows and separated into groups (power, ac control, dc signal). Each group of terminal blocks shall have a minimum of 25% spares.
4. Discrete inputs and outputs (DI and DO) shall have 2 terminals per point with adjacent terminal assignments. All active and spare PLC and controller points shall be wired to terminal blocks. Wiring for input/output points for the PLC shall be allowed to terminate directly to interposing relay.
5. Analog inputs and outputs (AI and AO) shall have 3 terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. All active and spare PLC and controller points shall be wired to terminal blocks. Wiring for input/output points for the PLC shall be allowed to terminate directly to surge protector.
6. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.
7. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6 inches of the side panel or adjacent terminal or within 8 inches of the bottom of free standing panels, or within 3 inches of stanchion mounted panels, or 3 inches of adjacent wireway.
8. Circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards shall be isolated with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Isolation switch block shall be an Allen Bradley Model 1492-H7 or equal. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
9. Wire Tagging:
  - a. Panel connection wiring shall be tagged at terminations with machine printed slip on type tags.
  - b. Provide wire/cable tag designations on all wiring diagrams submitted to the OWNER. Place tag within 2 inches of any wiring termination, affixing tag to prevent the tag from sliding more than 2 inches from the terminal as the result of gravity and vibration.

E. All wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.

F. All wiring shall be clearly tagged and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and loop drawings prepared by the PCSS. All power

wiring, control wiring, grounding, and dc wiring shall utilize different color insulation for each wiring system used. The color coding scheme shall be:

- a. Incoming 120 Vac Hot - Black
  - b. 120 Vac Hot wiring downstream of panel circuit breaker – Red
  - c. 120 Vac Hot wiring derived from a UPS system – Red with Black stripe
  - d. 120 Vac neutral - White
  - e. Ground - Green
  - f. DC power or control wiring – Blue
  - g. DC analog signal wiring – Black (+), White (-)
  - h. Foreign voltage – Yellow
- G. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. All instruments requiring 120 Vac power shall be powered from the UPS source in the panel where the instrument signals lands.
- H. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
- I. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
- J. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
- K. Field Entrance Internal Wiring:
1. Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
  2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
  3. All conduit entering or leaving equipment shall be coordinated, in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination area for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the OWNER and ENGINEER.
- L. Fusing of PLC Inputs and Outputs:
1. All PLC analog inputs and outputs shall be individually fused for each channel.
  2. All discrete inputs and outputs shall be buffered with relays from the field connections. Discrete points shall be fused for each circuit group with no less than 1 fuse per PLC I/O card.
- M. Buffering PLC Discrete Inputs and Outputs:
1. All PLC discrete inputs and outputs shall be individually buffered with relays as

specified. Where field voltage is ac reed type relays shall not be used.

## 2.8 MISCELLANEOUS

- A. Face-mounted equipment shall be flush or semi-flush, with flat black escutcheons. Cutouts for future equipment and holes resulted from removal of existing devices shall be blanked off with suitable covers as required to retain the cabinet's NEMA rating. Component identification shall be hot ink stamped on the panel interior.
- B. Hardware and Fittings: All miscellaneous hardware and fittings shall be Type 316 stainless steel.
- C. The bottom 12 inches of free-standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing. If top fed, the top 12 inches of free-standing panels shall be free of all devices.

## 2.9 FACTORY TESTING

- A. General
  - 1. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.
  - 2. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.
  - 3. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the OWNER and ENGINEER's approval.
- B. Witnessed Factory Testing
  - 1. All Panels shall remain at the manufacturer's facility, for a single Witness Testing by the OWNER and ENGINEER, if required by Section 40 61 21 - Instrumentation and Control System Testing and Commissioning. The manufacturer may, for their requirements or satisfaction, make such inspections or tests as he deems necessary, but such tests, not witnessed by the OWNER and ENGINEER, will not be acceptable as a substitute for the Factory Witness Testing of every panel.
  - 2. Under no circumstances will the equipment be approved for shipment, nor will the equipment be accepted by the OWNER, if witness testing is specified and the equipment is shipped without the testing being witnessed.
  - 3. The OWNER and ENGINEER will witness the Factory Testing, as described above, including a complete inspection of the mounting and wiring of each device, to assure conformance with this specification. Any Panel not meeting all requirements of this specification will be rejected.
  - 4. Subsequent to the Factory Testing, the manufacturer may ship the Approved Panels when desired, to the Project Site or an Assembly Site, as required by the Specifications. Rejected Panels shall be revised to meet the Specifications and a subsequent Witnessed Test shall be required and scheduled with the OWNER and ENGINEER. All additional expense related to retesting shall be at the CONTRACTOR's

expense.

5. The OWNER and ENGINEER representatives who are witnessing the testing shall approve all travel arrangements, including the airline selected, flight times, ground transportation, hotel selected, testing agenda, etc.
6. The OWNER and ENGINEER shall have direct communications with the person who is responsible for local arrangements and has the authority to pay for those expenses prior to leaving the project location, or other designated location.
7. The CONTRACTOR shall submit the testing agenda for approval at least 30 days prior to the test date, or the test date shall be rescheduled with no change in the contract price or time.
8. Where travel is overnight, testing shall not start on the arrival day.
9. OWNER and ENGINEER Travel Expenses:
  - a. OWNER and ENGINEER representatives shall not have to provide for any out of pocket expenses related to the trip, transportation, meals or incidentals that would require later reimbursement.
  - b. The CONTRACTOR shall provide, and pay for, all travel, including airfare, ground shuttle or taxi, to and from the OWNER and ENGINEER's office or residence. Airfare shall be non-stop if available, coach class or better, from Dallas/Fort Worth.
  - c. Ground transportation at any destination shall be provided by the CONTRACTOR unless prior agreement otherwise has been made.
  - d. The CONTRACTOR shall provide for hotel, meals, travel and incidentals to be paid for by the CONTRACTOR at the testing location, whose equipment is being tested. If the hotel offers restaurants, those charges shall be covered in the Hotel expenses. If meals are not offered at the hotel, transportation to restaurants and the cost of those meals shall be provided by the CONTRACTOR.
  - e. Access to the Internet shall be provided at the testing location.

## 2.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Spare part requirements shall be as indicted in the table below.

Description	Percent of Each Type and Size Used	No Less Than
Dc power supplies	20	2
Fuses	20	10
Relays and bases	20	10
Analog surge protectors	20	3
Power line surge protectors	20	2

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the equipment.

- B. Housekeeping pads shall be included for the floor mounted panels as detailed on the drawings.
- C. Check concrete pads and baseplates for uniformity and level surface.
- D. Verify that the equipment is ready to install.
- E. Verify field measurements are as instructed by manufacturer.

### 3.2 INSTALLATION

- A. The CONTRACTOR shall install all equipment per the manufacturer's recommendations and contract drawings.
- B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw.
- C. Install required safety labels.

### 3.3 RACEWAY SEALING

- A. Where raceways enter control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.
- B. This requirement shall be strictly adhered to for all raceways in the conduit system.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.
- C. Provide laminated copies of the control schematics along with the final approved I/O list in each enclosure door pocket.

### 3.5 CLEANING

- A. Remove all rubbish and debris from inside and around the panel. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

### 3.6 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

### 3.7 TESTING AND COMMISSIONING

- A. Testing and Commissioning: Accomplished in accordance with the requirements of Section 01 70 00 - Execution and Closeout Requirements and Section 40 61 21 - Instrumentation and Control System Testing and Commissioning.

**END OF SECTION**

**SECTION 40 71 00  
FLOW MEASUREMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section provides requirements for furnishing, installation, and services for flow measurement instruments as detailed on the Drawings.
- B. Instrument Schedules have been provided at the end of the specification section. Schedules may not be all inclusive. Refer to P&IDs and Mechanical sheets for instruments to be furnished and installed on the project.
- C. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System Abbreviations and References. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.
- B. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Control System Integrator unless otherwise directed by the OWNER/ENGINEER.

**1.3 ADMINISTRATIVE REQUIREMENTS – NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements: Comply with the submittal requirements of Section 01 30 00 - Administrative Requirements, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
- B. Submit to the ENGINEER the following:
  - 1. Manufacturer's name and address, as well as Manufacturer's product name and complete model number for all equipment and accessories proposed for use
  - 2. Materials of Construction for equipment housing
  - 3. Dimensions
  - 4. Measurement accuracy

5. Measurement range for proposed level measurement system
  6. Enclosure NEMA rating(s) for components
  7. NEC Area Classification for model(s) chosen
  8. Power requirements and consumption in Voltage, Wattage and Amperage
  9. Output options
  10. Parts list for all components in sufficient detail to allow an item-by-item comparison with the Contract documents.
- C. Manufacturer's Instructions for the shipping, handling, storage, installation, start-up, operation, and maintenance, with schedule, of the equipment (in both hardcopy and digital formats). Include spare parts lists, instructions for instrument calibration and programming, instrument testing sheets, and schematics.
- D. Manufacturer's certification of satisfactory installation, calibration, and testing.
- E. Proof of Warranty as indicated.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer:
1. Products:
    - a. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include (unless "No Equal" is quantified), but are not limited to, have been named within the various paragraphs of this Section.
    - b. The listing of specific manufacturers within the various paragraphs of this Section does not imply acceptance of their products that do not meet the specified ratings, features and functions. manufacturers listed within the various paragraphs of this Section are not relieved from meeting these specifications in their entirety.
    - c. Manufacturer of the products under this Section shall be experienced, producing meters that are fully developed, field proven, and of standardized designs.
    - d. To the greatest extents possible, provide equipment that is the product of one (1) manufacturer in order to achieve standardization of operation, maintenance, spare parts, and Manufacturer's service.
  2. Services:
    - a. If indicated in the individual instrumentation paragraphs, the instrument manufacturer or manufacturer's certified service representative shall provide start-up and training services. This work shall not be done by the CONTRACTOR or Control System Integrator.
    - b. The start-up services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter in order to provide reliable measurement at the instrument and to a remote system. The vendor shall work with the Control System Integrator to verify the transmitter sends correct information to the remote system (i.e., that the scaling and units are the same at the instrument and on the remote operator interface).



- c. While the instrument manufacturer or manufacturer's certified service representative is starting up the instrumentation, training shall be provided to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.
- d. An authorized Manufacturer's representative shall inspect the installation of all work furnished in this Section and shall provide a Manufacturer's certificate showing that the equipment has been satisfactorily installed, calibrated, and tested.

B. Installer:

- 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.
- B. The Contractor shall be responsible for replacing, at his expense, instruments that are not stored in strict conformance with the Manufacturer's recommendations.

1.7 SITE CONDITIONS

A. Operating Conditions:

- 1. Ambient Conditions: Provide equipment suitable for ambient conditions in accordance with environment requirement paragraphs specified below.
- 2. Field Locations: Field equipment may be subjected to ambient temperatures from 0-120° F, with direct radiation, and relative humidity from 45 to 96% with condensation. Field equipment will also experience rain, freezing rain, and snow.
- 3. Power Supply: Power supply will be 120 VAC, single-phase, 60 Hz commercial power. Voltage variations will be at least plus or minus 8%. Certain loops shall have integral power supply as indicated on the drawings.
- 4. Standard Signal:
  - a. Output Signal. Each instrument, which outputs a signal, shall output the standard 4-20 mA signal. The signal shall be constant over a load range of 0-600 Ω.
  - b. Input Signal.
    - 1) Electronic devices, such as controllers, match function devices, etc., shall have an input impedance of one mega-ohm minimum for an input signal of 1-5 VDC.
    - 2) The 1-5 VDC signal shall be developed by the standard 4-20 mA transmitted signal through a precision 250 Ω, 1 W resistor.
    - 3) These requirements allow several receiving units to monitor the same transmitting unit without causing any perturbation of the received signal.
    - 4) Receiving devices shall not be wired in parallel.

B. Components, Hazardous Area Location:

1. Assure equipment located in hazardous areas is suitable for applicable classification by use of explosion-proof housings or equipment and barriers approved as "intrinsically safe" by either UL or FM.
  2. Locate barriers in cabinets at hazardous area boundaries. Use dual barriers in loops in order to prevent grounding loop at the barrier.
- C. Components, Submerged Locations:
1. Those instruments that are submerged in a liquid or are located in submersible area shall meet NEMA 6P ratings approval

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the control system that fail(s) in materials or workmanship within the specified warranty period.
1. Warranty Period: Two (2) years from the date of completion of the Site Acceptance Test.
  2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty, as well as replacement of defective work.

## PART 2 - PRODUCTS

### 2.1 FULL BODY MAGNETIC FLOW METER

- A. Meter shall be composed of a flow tube and compatible transmitter. Refer to Instrument Schedule at the end of this specification section for a listing of instruments.
- B. Manufacturers:
1. Emerson/Rosemount; 8700 Series
  2. Endress+Hauser; Promag W 400
  3. Siemens, Sitrans; F M MAG 5100 W
- C. Requirements:
1. Flow Tube:
    - a. Function/Performance:
      - 1) Operating Temperature: Process liquid temperatures of 0 to 140 degrees F or greater dependent upon liner and an ambient of minus 30 to 150 degrees F.
      - 2) Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.
      - 3) Pressure rating: Equal to piping system where meter is installed.
      - 4) Additional: Meter shall be capable of running empty indefinitely without damage to any component.
    - b. Flanges: ANSI 150 lb. carbon steel, as required by the piping system, unless otherwise indicated. ANSI 150 lb. stainless steel flanges shall be used on all SS process pipes.
    - c. Metering Tube: 304 stainless steel or equivalent.

- d. Pressure Range: 0-150 PSI, unless otherwise stated on the Drawings.
  - e. Liner: The sensor tube shall be lined based upon the size of the flow meter and the process media conditions, CONTRACTOR to confirm. Default liner shall be polyurethane or composite elastomer unless otherwise indicated on the Drawings, in the Instrument Device Schedule or as recommended by the Manufacturer.
  - f. Electrodes: 316 stainless steel standard minimum requirements. All electrodes to be compatible with process fluid as indicated on the Drawings or electrodes to be supplied as listed in the Instrument Schedule.
  - g. For sludge, polymer, or any slurry application where the electrodes will be coated, a self-cleaning or a removable electrode option must be provided with that meter.
  - h. Housing: For meters with remote mounted transmitters, meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.
  - i. Finish: All external surfaces shall have a chemical and corrosion resistant finish.
2. Transmitter:
- a. Microprocessor based; intelligent transmitter compatible with flow tube provided.
  - b. Integral mount or mounted remote from the flow tube as shown on the drawings or as required by the physical location.
  - c. Functional/Performance:
    - 1) Accuracy (including flow tube): Plus/minus 0.5 percent of flowrate or better.
    - 2) Operating Temperature: -20 to 140 degrees F.
    - 3) Output: Isolated 4-20 mA. Current output adjustable over the full range of the instrument. Provide dry contacts to indicate reverse flow and pulse totalized reading.
    - 4) Diagnostics: Self diagnostics with on screen display of faults.
    - 5) Keypad/Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.
    - 6) Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.
    - 7) Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.
  - d. Physical:
    - 1) Transmitter shall be suitable for surface or pipe stand mounting.
    - 2) Enclosure shall be NEMA 4X.
  - e. Power Requirements:
    - 1) The transmitter shall be 120 VAC powered instrument.

D. Accessories/Documentation Required:

1. Factory calibration: All meters shall be factory calibrated. A copy of the calibration report shall be included in the O&M manual.
2. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured and must be compatible with process fluid and with the process pipe.
3. For meters with remote mounted transmitters, signal cable for installation between the flow tube and the transmitter. Length shall be as required by installation as indicated on the Drawings.

2.2 UNSCHEDULED DEVICES

A. Instrument Sunshade:

1. Provide instrument sunshade when indicated in contract documents.
2. Materials: 304 stainless steel, with hinged front, per stand detail.

B. Instrument Enclosures:

1. Provide instrument enclosures when indicated in contract documents with heaters.
2. Materials: Fiberglass reinforced polyester.
3. Manufacturer and Product; O'Brien Corp.; VIPAK Series.

C. Mounting Stands and Brackets:

1. Materials:
  - a. Standard 2-inch pipe mounts with sealed components.
  - b. Provide 2 5/8-inch channel section, stainless steel or aluminum.
    - 1) Acceptable manufacturers: Unistrut.
2. Finish: Zinc Arc Supply metalized coating spray, if not stainless or aluminum.
3. Mounting Hardware: Bolts, nuts, washers; Type 316 stainless steel.
4. Manufacturer and Product: O'Brien Corp.; Saddlepak Series.

D. External Power Supply: Provide an external weatherproof on-off switch for each instrument obtaining power from an external power source (non-loop powered).

E. Analog Field Surge Protection:

1. Provide field surge protection on all 4-20 mA inputs/outputs on all field mounted instruments.
2. Surge protection device shall protect field instrumentation from impulses up to 500 V or 10,000 A induced by lightning strikes or heavy electrical equipment.
3. Manufacturer and Product; Crouse Hinds, MTL Series or Citel, TSP Series.

F. Instrument Nameplates

1. Component identification for field devices:
  - a. Inscription: Component tag number.
  - b. Materials: 16-gauge, Type 304 stainless steel.
  - c. Letters: 3/16-inch imposed.

- d. Mounting: Affix to component with 16 gauge or 18-gauge stainless steel wire or stainless steel
2. Panel Face: Component identification located on panel face under or near component.
  - a. Locations and Inscription: As shown.
  - b. Materials: Laminated plastic attached to panel with stainless steel screws.
  - c. Letters: 3/16-inch white on black background, unless otherwise noted.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordination: Coordinate equipment delivery with completion of other work to minimize field handling of each device.

### 3.2 INSTALLATION

- A. General Requirements:
  1. Examine contract drawings and shop drawings for equipment in order to determine best arrangement for work as a whole.
  2. Mount pipe, and connect field devices in accordance with contract drawings, specification and manufacturer's installation instructions.
  3. Avoid tubing, piping and conduit interferences.
  4. Locate equipment to be accessible for operation, maintenance and replacement.
  5. Mount field transmitters 40 inches above floor, work platform, or as sensing line slope requires per manufacturer's instructions and in a location to allow convenient access for readability, calibration and maintenance. Coordinate tap location and meter location with ENGINEER prior to beginning work.
- B. Device Mounting and Location Requirements.
  1. Where specifications and contract drawings do not delineate precise installation procedures, use API RP550 as a guide to installation procedures. Submit sketch for OWNER approval prior to installation.
  2. Locate field-mounted instruments as shown on drawings or as designated by the OWNER's representative or ENGINEER.
  3. Secure support pipes, stands or brackets of material with sufficient strength to prevent excess vibration or movement.
  4. Where field devices are shown as yoke mounted on a floor stand, a wall bracket fabricated from two channel sections, 1 5/8 inches sized, mounted to a wall or column is considered equal.
  5. Make channel section long enough to mount at least two field devices. Use aluminum or stainless steel for fabrication.
  6. Locate instrument-mounting stands within 5 feet of primary element, unless otherwise indicated. Make stands freely accessible.
  7. Locate indicating instruments which must be visible for automatic control adjustment or manual operation to be visible from the adjustment or operating point. If plot or piping arrangement precludes this, make other provisions for indication at the adjustment or operation point.

8. Install instrument mounting stands after all conduit and pipe has been installed, except conduit serving devices on stand.
9. Install instrument process piping and tubing from each primary shutoff valve to appropriate gauge, sensor, meter, analyzer, control panel connections, etc.
10. Clean piping, tubing and components thereof prior to installation. This shall include but is not limited to special cleaning procedures for oxygen service when so required.
11. Adjust pulsation dampers to eliminate rapid fluctuations of gauge or switch but to retain sensitivity to pressure changes.

### 3.3 COMMISSIONING

#### A. Commissioning:

1. Commissioning of instruments shall be in accordance with manufacturers' instructions, the product data and shop drawings, Section 40 61 00 - Instrumentation and Control System General Provisions.

#### B. Manufacturers' Start-Up and Training Services

1. Where indicated in the product description, the instrument manufacturer or manufacturer's certified service representative shall provide start-up and training services. This work shall not be done by the Control System Integrator.
2. The start-up services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter in order to provide reliable measurement at the instrument and to a remote system. The vendor shall work with the Process Control System Integrator to verify the transmitter sends correct information to the remote system (i.e., that the scaling and units are the same at the instrument and on the remote operator interface).
3. While the instrument manufacturer or manufacturer's certified service representative is starting up the instrumentation, training shall be provided to the OWNER's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

#### C. General Requirements

1. Notify the OWNER/ENGINEER in writing at least 24 hours in advance of any test. All tests executed without such notification are invalid and shall be repeated. The OWNER/ENGINEER reserves the right to witness any test, inspection, calibration or start-up activity.
2. Perform commissioning of each device, subsystem and system under direct supervision of the individual manufacturer's factory-trained representative.
3. Reports:
  - a. Prepare Report showing test procedures, conditions and results of each test. In the test report, give applicable contract requirements, manufacturer's performance specifications, and permissible tolerances at each test point, actual values of test signals and actual values of test results.
  - b. Check off List:
    - 1) Maintain a check off list by loop number indicating tasks remaining to be done to make loop operational.
    - 2) Submit check off list form at least 60 days before commissioning starts.

- 3) Submit check off lists when requested by OWNER/ENGINEER.
- 4) Lists will be requested no more frequently than once a week.

D. Scheduling Guidelines for Commissioning Phases

1. Perform all commissioning in accordance with the instructions on the Contract Drawings, these Specifications, manufacturer's instruction manuals and the direction of the OWNER/ENGINEER.
2. Commission field devices, after installation of field instruments and prior to commissioning the instrument or the control panel.
3. After installation of the instrument or control panel and prior to loop commissioning, commission panel-mounted devices and systems.
4. After commissioning field devices and panel-mounted devices, commission loops.

E. Requirements

1. Transmitters and Receivers:
  - a. Remove shipping stops before starting with these procedures.
  - b. Have manufacturer's instruction manuals available.
  - c. Install miscellaneous components such as charts, illumination, etc., which have been supplied separately but are integral parts of equipment.
  - d. Test and exercise each instrument to demonstrate correct operation, first individually, then collectively as a functional network.
  - e. Check calibration of and recalibrate, where necessary, instruments at a minimum of 4 points over full operational range and prove instruments to be within specified accuracy.
  - f. Calibrate instruments individually and, where applicable, as loop (i.e., transmitter, controller and valve).
  - g. Specified accuracy for loop is defined as root-mean-square-summation (rms) of individual device specified accuracies.
  - h. Individual device specified accuracy requirements shall be as specified by contract requirements or by published manufacturer accuracy specifications whenever contract accuracy requirements are not specified.
  - i. Test each loop by applying simulated analog and/or discrete inputs to first elements of loop (i.e., applying simulated analog and/or discrete sensor signals) and measuring outputs from final elements of loop, (i.e., controllers, alarms, indicators, etc.).
  - j. Apply continuously variable analog inputs to verify proper operation and setting of discrete devices (i.e., alarms, etc.).
  - k. Make provisional settings on controllers, alarms, etc., during loop installation tests.
  - l. Prepare calibration report on each instrument and loop.
- m. Integrators, Ratio Relay, and Related Devices:
  - n. Check devices in conformance with manufacturer's recommendations.
  - o. Receiver integrators may be calibrated for proper operation and multiplication factor by feeding maximum input signal for a specified period of time using a

- stopwatch.
- p. Ratio signals may be simulated to check proper ratio settings and output.
2. Flow Meters and Level Transmitters:
    - a. Perform volumetric draw down test for all flow meters and level transmitters.
    - b. Prepare test report for each meter and level transmitter.
    - c. If test results conflict with calibration report recalibrate in accordance with subparagraph A above and repeat volumetric draw down test.
    - d. Continue until draw down test results prove calibration to be correct.
  3. Interlocks: Ring and check interlocking circuits for conformance to Plans and Specifications.
  4. Start-up of Instruments:
    - 1) Test each control loop under start-up and steady-state operating conditions to verify that proper and stable control is achieved using instruments in each instrument panel and control panel.
    - 2) Test control of final control elements using specified modes of manual and automatic control.
    - 3) Demonstrate bumpless transition between control station modes.
    - 4) Use signals from transducers, sensors and transmitters.
    - 5) Simulated input data signals may be used subject to prior written approval by the OWNER/ENGINEER.
    - b. Set proportional band, reset rate, and derivative settings for each control as recommended by manufacturer.
    - c. Verify transient stability of each control loop by applying control signal disturbances, monitoring amplitude and decay rate of control parameter oscillations and making necessary controller adjustments to eliminate excessive oscillatory amplitudes and decay rates while retaining control sensitivity. Verify proper suppression of "reset wind-up."
  5. Component Calibration Sheet
    - a. CONTRACTOR shall be responsible for calibration and ringing out all devices that are to be interfaced with the distributed control system. This shall include devices purchased and installed under other contracts.
    - b. Each active instrument element (except simple hand switches, lights, etc.) and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for signoff by the Process Control System Integrator or its subcontractor.
      - 1) Project name.
      - 2) Loop name.
      - 3) Component tag number or I/O module number.
      - 4) Component code number.
      - 5) manufacturer.
      - 6) Module number/serial number.
      - 7) Summary of function requirements, for example:



- 8) For indicators and recorders: scale and chart ranges.
  - 9) For transmitters/converters: input and output ranges.
  - 10) For computing elements.
  - 11) I/O modules: required and actual inputs or outputs of 0, 10, 50, and 100% of span, rising and falling.
  - 12) Space for comments.
  - 13) Space for signoff by Process Control System Integrator.
6. The Control System Integrator shall maintain the Loop Status Reports and Component Calibration Sheets at the job site and make them available to the ENGINEER at any time.

### 3.4 TESTING AND TRAINING

- A. Testing: Accomplished in accordance with the requirements of Section 40 61 21 - Instrumentation and Control System Testing and Commissioning and Section 01 70 00 - Execution and Closeout Requirements.
- B. Training: Accomplished in accordance with the requirements of Section 40 61 26 - Instrumentation and Control System Training and Section 01 70 00 - Execution and Closeout Requirements.

### 3.5 INSTRUMENT SCHEDULES

- A. Provide field instruments, as listed in the Instrument Schedules after END OF SECTION, of the range, type, in accordance with the mechanical drawings, control narratives, and P&ID's. Schedules may not be all inclusive.

**END OF SECTION**



**SECTION 40 72 00  
LEVEL MEASUREMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section provides requirements for furnishing, installation, and services for level measurement instruments as detailed on the Drawings.
- B. Instrument Schedules have been provided at the end of the specification section. Schedules may not be all inclusive. Refer to P&IDs and Mechanical sheets for instruments to be furnished and installed on the project.
- C. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 "Instrumentation and Control System Abbreviations and References." In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.
- B. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Control System Integrator unless otherwise directed by the OWNER/ENGINEER.

**1.3 ADMINISTRATIVE REQUIREMENTS – NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements: Comply with the submittal requirements of Section 01 30 00 "Administrative Requirements", Section 40 61 00 "Instrumentation and Control System General Provisions", and as described below.
- B. Submit to the ENGINEER the following:
  - 1. Manufacturer's name and address, as well as Manufacturer's product name and complete model number for all equipment and accessories proposed for use
  - 2. Materials of Construction for equipment housing
  - 3. Dimensions
  - 4. Measurement accuracy

5. Measurement range for proposed level measurement system
  6. Enclosure NEMA rating(s) for components
  7. NEC Area Classification for model(s) chosen
  8. Power requirements and consumption in Voltage, Wattage and Amperage
  9. Output options
  10. Parts list for all components in sufficient detail to allow an item-by-item comparison with the Contract documents.
- C. Manufacturer's Instructions for the shipping, handling, storage, installation, start-up, operation, and maintenance, with schedule, of the equipment (in both hardcopy and digital formats). Include spare parts lists, instructions for instrument calibration and programming, instrument testing sheets, and schematics.
- D. Manufacturer's certification of satisfactory installation, calibration, and testing.
- E. Proof of Warranty as indicated.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer:
1. Products:
    - a. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include (unless "No Equal" is quantified), but are not limited to, have been named within the various paragraphs of this Section.
    - b. The listing of specific manufacturers within the various paragraphs of this Section does not imply acceptance of their products that do not meet the specified ratings, features and functions. manufacturers listed within the various paragraphs of this Section are not relieved from meeting these specifications in their entirety.
    - c. Manufacturer of the products under this Section shall be experienced, producing meters that are fully developed, field proven, and of standardized designs.
    - d. To the greatest extents possible, provide equipment that is the product of one (1) manufacturer in order to achieve standardization of operation, maintenance, spare parts, and Manufacturer's service.
  2. Services:
    - a. If indicated in the individual instrumentation paragraphs, the instrument manufacturer or manufacturer's certified service representative shall provide start-up and training services. This work shall not be done by the CONTRACTOR or Control System Integrator.
    - b. The start-up services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter in order to provide reliable measurement at the instrument and to a remote system. The vendor shall work with the Control System Integrator to verify the transmitter sends correct information to the remote system (i.e., that the scaling and units are the same at the instrument and on the remote operator interface).

- c. While the instrument manufacturer or manufacturer's certified service representative is starting up the instrumentation, training shall be provided to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.
- d. An authorized Manufacturer's representative shall inspect the installation of all work furnished in this Section and shall provide a Manufacturer's certificate showing that the equipment has been satisfactorily installed, calibrated, and tested.

B. Installer:

- 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.
- B. The Contractor shall be responsible for replacing, at his expense, instruments that are not stored in strict conformance with the Manufacturer's recommendations.

### 1.7 SITE CONDITIONS

A. Operating Conditions:

- 1. Ambient Conditions: Provide equipment suitable for ambient conditions in accordance with environment requirement paragraphs specified below.
- 2. Field Locations: Field equipment may be subjected to ambient temperatures from 0-120 degrees F, with direct radiation, and relative humidity from 45 to 96% with condensation. Field equipment will also experience rain, freezing rain, and snow.
- 3. Power Supply: Power supply will be 120 Vac, single-phase, 60 Hz commercial power. Voltage variations will be at least plus or minus 8%. Certain loops shall have integral power supply as indicated on the drawings.
- 4. Standard Signal:
  - a. Output Signal. Each instrument, which outputs a signal, shall output the standard 4-20 mA signal. The signal shall be constant over a load range of 0-600  $\Omega$ .
  - b. Input Signal.
    - 1) Electronic devices, such as controllers, match function devices, etc., shall have an input impedance of one mega-ohm minimum for an input signal of 1-5 Vdc.
    - 2) The 1-5 Vdc signal shall be developed by the standard 4-20 mA transmitted signal through a precision 250  $\Omega$ , 1 W resistor.
    - 3) These requirements allow several receiving units to monitor the same transmitting unit without causing any perturbation of the received signal.
    - 4) Receiving devices shall not be wired in parallel.

B. Components, Hazardous Area Location:

1. Assure equipment located in hazardous areas is suitable for applicable classification by use of explosion-proof housings or equipment and barriers approved as "intrinsically safe" by either UL or FM.
  2. Locate barriers in cabinets at hazardous area boundaries. Use dual barriers in loops in order to prevent grounding loop at the barrier.
- C. Components, Submerged Locations:
1. Those instruments that are submerged in a liquid or located in submersible areas shall meet NEMA 6P ratings approval.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the control system that fail(s) in materials or workmanship within the specified warranty period.
1. Warranty Period: Two (2) years from the date of completion of the Site Acceptance Test.
  2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty, as well as replacement of defective work.

## PART 2 - PRODUCTS

### 2.1 LEVEL INDICATING RADAR LEVEL

- A. Transmitter shall be non-contact, microwave type level meter. Refer to Instrument Schedule at the end of this specification section for a listing of instruments.
- B. Manufacturers:
1. Emerson/Rosemount; 3408
  2. Endress+Hauser; Micropilot NMR81
  3. Siemens; LR250
- C. Requirements:
1. Transducer
    - a. Function/Performance
      - 1) Measuring Range: Transducer range shall be suitable for the installation indicated on the Drawings, up to 33 ft (15m).
      - 2) Temperature Range: -20 to 60 degrees C.
      - 3) Accuracy: Plus or minus 0.02%
      - 4) Relative Humidity: Zero to 100 percent.
    - b. Physical
      - 1) Housing: Transducers shall be potted/encapsulated in a Kynar, 316 stainless steel, or other chemical and corrosion-resistant housing. Where indicated on the Drawings, transducers shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.
      - 2) The surface of transducers shall be Teflon-coated where mounted on chemical tanks and exposed to vapors in the tanks that are not compatible

with the transducer material.

- 3) Frequency: 80 GHz.
- 4) Antenna: PTFE with suitable seal material for corrosive environments.
- 5) Transducers shall be suitable for flange mounting as indicated on the Drawings or Instrument Device Schedule. Appropriate mounting hardware shall be provided. Flanges shall be 4 inch or as indicated on Drawings.

- c. Output: 4-20mA Hart
- d. Power Requirements: 24 VDC Loop powered.
- e. Accessories Required
  - 1) Hand-held programmer or configuration on integrated display with pushbuttons.

D. Accessories/Documentation Required:

1. Provide a certificate of conformance/calibration after installation for each flowmeter.
2. The supplier shall be responsible for coordinating all transducer mounting requirements and shall furnish dimensional and elevation drawings to ensure a proper and satisfactory installation.
3. Where indicated on drawings, provide a remote mounted, loop-powered 5-digit indicator with bar graph and activated backlighting in a NEMA 4X enclosure.
4. Hand-held programmer where required for configuration and calibration of the instrument.
5. Sunshield for protection antenna when exposed to direct sunlight, when mounted outside.

## 2.2 FLOAT SWITCH (BALL)

A. Float switch shall be composed of mercury free ball float, refer to Instrument Schedule at the of this specification section for a listing of instruments.

B. Manufacturers:

1. Contegra FS 90
2. Siemens Water Technologies Model 9G-EF.

C. Requirements:

1. Function/Performance
  - a. Differential: Less than 8 inches.
  - b. Switch Rating: 1 amps at 120 VAC or 100 VA @ 120 VAC
  - c. Provide NO or NC type contact for fail-safe operation or as shown on the drawings.
2. Physical
  - a. Float: 316 stainless steel, Teflon or non-stick coating, minimum 5 in diameter.
  - b. Totally encapsulated switch.
  - c. Cable shall be heavy-duty, PVC or equivalent jacketed integral to float.

D. Accessories/Documentation Required:

1. Provide stainless steel hardware either for fixed (conduit) or weighted application as

shown on Drawings.

2. Lead wire shall be a waterproof cable of sufficient length so that no splice or junction box is required in the vault/wetwell.

### 2.3 FLOAT SWITCH (PLUNGER)

- A. Float switch shall be composed of a hermetically sealed reed switch located inside the stem. The switch is activated by a magnet located in the float. As the float rises and falls, the magnetic field passing the switch (in the stem) causes the switch to actuate, refer to Instrument Schedule at the end of this specification section for a listing of instruments.
- B. Manufacturers:
  1. Contegra FS 202
- C. Requirements:
  1. Function/Performance
    - a. Differential: Less than 3/8" rise..
    - b. Switch Rating: 0.5 amps at 120 VAC
    - c. Provide NO or NC type contact for fail-safe operation or as shown on the drawings.
  2. Physical
    - a. All construction shall be of PVC, PBT and Buna N for corrosion resistance.
    - b. The junction box shall be NEMA 4X.
- D. Accessories/Documentation Required:
  1. Provide with 1/2" Threaded Fitting.

### 2.4 UNSCHEDULED DEVICES

- A. Instrument Sunshade:
  1. Provide instrument sunshade when indicated in contract documents.
  2. Materials: 304 stainless steel, with hinged front, per stand detail.
- B. Instrument Enclosures:
  1. Provide instrument enclosures when indicated in contract documents with heaters.
  2. Materials: Fiberglass reinforced polyester.
  3. Manufacturer and Product; O'Brien Corp.; VIPAK Series.
- C. Mounting Stands and Brackets:
  1. Materials:
    - a. Standard 2-inch pipe mounts with sealed components.
    - b. Provide 2 5/8-inch channel section, stainless steel or aluminum.
      - 1) Acceptable manufacturers: Unistrut.
  2. Finish: Zinc Arc Supply metalized coating spray, if not stainless or aluminum.
  3. Mounting Hardware; Bolts, nuts, washers; Type 316 stainless steel.
  4. Manufacturer and Product; O'Brien Corp.; Saddlepak Series.
- D. External Power Supply: Provide an external weatherproof on-off switch for each instrument



obtaining power from an external power source (non-loop powered).

E. Analog Field Surge Protection:

1. Provide field surge protection on all 4-20 mA inputs/outputs on all field mounted instruments.
2. Surge protection device shall protect field instrumentation from impulses up to 500 V or 10,000 A induced by lightning strikes or heavy electrical equipment.
3. Manufacturer and Product; Crouse Hinds, MTL Series or Citel, TSP Series.

F. Instrument Nameplates

1. Component identification for field devices:
  - a. Inscription: Component tag number.
  - b. Materials: 16-gauge, Type 304 stainless steel.
  - c. Letters: 3/16-inch imposed.
  - d. Mounting: Affix to component with 16 gauge or 18-gauge stainless steel wire or stainless steel
2. Panel Face: Component identification located on panel face under or near component.
  - a. Locations and Inscription: As shown.
  - b. Materials: Laminated plastic attached to panel with stainless steel screws.
  - c. Letters: 3/16-inch white on black background, unless otherwise noted.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordination: Coordinate equipment delivery with completion of other work to minimize field handling of each device.

### 3.2 INSTALLATION

A. General Requirements:

1. Examine contract drawings and shop drawings for equipment in order to determine best arrangement for work as a whole.
2. Mount pipe, and connect field devices in accordance with contract drawings, specification and manufacturer's installation instructions.
3. Avoid tubing, piping and conduit interferences.
4. Locate equipment to be accessible for operation, maintenance and replacement.
5. Mount field transmitters 40 inches above floor, work platform, or as sensing line slope requires per manufacturer's instructions and in a location to allow convenient access for readability, calibration and maintenance. Coordinate tap location and meter location with ENGINEER prior to beginning work.

B. Device Mounting and Location Requirements.

1. Where specifications and contract drawings do not delineate precise installation procedures, use API RP550 as a guide to installation procedures. Submit sketch for OWNER approval prior to installation.
2. Locate field-mounted instruments as shown on drawings or as designated by the

OWNER's representative or ENGINEER.

3. Secure support pipes, stands or brackets of material with sufficient strength to prevent excess vibration or movement.
4. Where field devices are shown as yoke mounted on a floor stand, a wall bracket fabricated from two channel sections, 1 5/8 inches sized, mounted to a wall or column is considered equal.
5. Make channel section long enough to mount at least two field devices. Use aluminum or stainless steel for fabrication.
6. Locate instrument-mounting stands within 5 feet of primary element, unless otherwise indicated. Make stands freely accessible.
7. Locate indicating instruments which must be visible for automatic control adjustment or manual operation to be visible from the adjustment or operating point. If plot or piping arrangement precludes this, make other provisions for indication at the adjustment or operation point.
8. Install instrument mounting stands after all conduit and pipe has been installed, except conduit serving devices on stand.
9. Install instrument process piping and tubing from each primary shutoff valve to appropriate gauge, sensor, meter, analyzer, control panel connections, etc.
10. Clean piping, tubing and components thereof prior to installation. This shall include but is not limited to special cleaning procedures for oxygen service when so required.
11. Adjust pulsation dampers to eliminate rapid fluctuations of gauge or switch but to retain sensitivity to pressure changes.

### 3.3 COMMISSIONING

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3. While the instrument manufacturer or manufacturer's certified service representative is starting up the instrumentation, training shall be provided to the OWNER's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

#### C. General Requirements

1. Notify the OWNER/ENGINEER in writing at least 24 hours in advance of any test. All

tests executed without such notification are invalid and shall be repeated. The OWNER/ENGINEER reserves the right to witness any test, inspection, calibration or start-up activity.

2. Perform commissioning of each device, subsystem and system under direct supervision of the individual manufacturer's factory-trained representative.
3. Reports:
  - a. Prepare Report showing test procedures, conditions and results of each test. In the test report, give applicable contract requirements, manufacturer's performance specifications, and permissible tolerances at each test point, actual values of test signals and actual values of test results.
  - b. Check off List:
    - 1) Maintain a check off list by loop number indicating tasks remaining to be done to make loop operational.
    - 2) Submit check off list form at least 60 days before commissioning starts.
    - 3) Submit check off lists when requested by OWNER/ENGINEER.
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1. Perform all commissioning in accordance with the instructions on the Contract Drawings, these Specifications, manufacturer's instruction manuals and the direction of the OWNER/ENGINEER.
2. Commission field devices, after installation of field instruments and prior to commissioning the instrument or the control panel.
3. After installation of the instrument or control panel and prior to loop commissioning, commission panel-mounted devices and systems.
4. After commissioning field devices and panel-mounted devices, commission loops.

E. Requirements

1. Transmitters and Receivers:
  - a. Remove shipping stops before starting with these procedures.
  - b. Have manufacturer's instruction manuals available.
  - c. Install miscellaneous components such as charts, illumination, etc., which have been supplied separately but are integral parts of equipment.
  - d. Test and exercise each instrument to demonstrate correct operation, first individually, then collectively as a functional network.
  - e. Check calibration of and recalibrate, where necessary, instruments at a minimum of 4 points over full operational range and prove instruments to be within specified accuracy.
  - f. Calibrate instruments individually and, where applicable, as loop (i.e., transmitter, controller and valve).
  - g. Specified accuracy for loop is defined as root-mean-square-summation (rms) of individual device specified accuracies.
  - h. Individual device specified accuracy requirements shall be as specified by contract requirements or by published manufacturer accuracy specifications

- whenever contract accuracy requirements are not specified.
- i. Test each loop by applying simulated analog and/or discrete inputs to first elements of loop (i.e., applying simulated analog and/or discrete sensor signals) and measuring outputs from final elements of loop, (i.e., controllers, alarms, indicators, etc.).
  - j. Apply continuously variable analog inputs to verify proper operation and setting of discrete devices (i.e., alarms, etc.).
  - k. Make provisional settings on controllers, alarms, etc., during loop installation tests.
  - l. Prepare calibration report on each instrument and loop.
  - m. Integrators, Ratio Relay, and Related Devices:
  - n. Check devices in conformance with manufacturer's recommendations.
  - o. Receiver integrators may be calibrated for proper operation and multiplication factor by feeding maximum input signal for a specified period of time using a stopwatch.
  - p. Ratio signals may be simulated to check proper ratio settings and output.
2. Flow Meters and Level Transmitters:
    - a. Perform volumetric draw down test for all flow meters and level transmitters.
    - b. Prepare test report for each meter and level transmitter.
    - c. If test results conflict with calibration report recalibrate in accordance with subparagraph A above and repeat volumetric draw down test.
    - d. Continue until draw down test results prove calibration to be correct.
  3. Level Switches:
    - a. Perform draw down test for each level switch. Set switch in accordance with Specifications or in absence of switch setting in Specifications, set in accordance with instructions from OWNER/ENGINEER.
  4. Interlocks: Ring and check interlocking circuits for conformance to Plans and Specifications.
  5. Start-up of Instruments:
    - 1) Test each control loop under start-up and steady-state operating conditions to verify that proper and stable control is achieved using instruments in each instrument panel and control panel.
    - 2) Test control of final control elements using specified modes of manual and automatic control.
    - 3) Demonstrate bumpless transition between control station modes.
    - 4) Use signals from transducers, sensors and transmitters.
    - 5) Simulated input data signals may be used subject to prior written approval by the OWNER/ENGINEER.
    - b. Set proportional band, reset rate, and derivative settings for each control as recommended by manufacturer.
    - c. Verify transient stability of each control loop by applying control signal disturbances, monitoring amplitude and decay rate of control parameter

oscillations and making necessary controller adjustments to eliminate excessive oscillatory amplitudes and decay rates while retaining control sensitivity. Verify proper suppression of "reset wind-up."

6. Component Calibration Sheet
  - a. CONTRACTOR shall be responsible for calibration and ringing out all devices that are to be interfaced with the distributed control system. This shall include devices purchased and installed under other contracts.
  - b. Each active instrument element (except simple hand switches, lights, etc.) and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for signoff by the Process Control System Integrator or its subcontractor.
    - 1) Project name.
    - 2) Loop name.
    - 3) Component tag number or I/O module number.
    - 4) Component code number.
    - 5) manufacturer.
    - 6) Module number/serial number.
    - 7) Summary of function requirements, for example:
    - 8) For indicators and recorders: scale and chart ranges.
    - 9) For transmitters/converters: input and output ranges.
    - 10) For computing elements.
    - 11) I/O modules: required and actual inputs or outputs of 0, 10, 50, and 100% of span, rising and falling.
    - 12) Space for comments.
    - 13) Space for signoff by Process Control System Integrator.
7. The Control System Integrator shall maintain the Loop Status Reports and Component Calibration Sheets at the job site and make them available to the ENGINEER at any time.

### 3.4 TESTING AND TRAINING

- A. Testing: Accomplished in accordance with the requirements of Section 40 61 21 "Instrumentation and Control System Testing and Commissioning" and Section 01 70 00 "Execution and Closeout Requirements."
- B. Training: Accomplished in accordance with the requirements of Section 40 61 26 "Instrumentation and Control System Training" and Section 01 70 00 "Execution and Closeout Requirements."

### 3.5 INSTRUMENT SCHEDULES

- A. Provide field instruments, as listed in the Instrument Schedules after END OF SECTION, of the range, type, in accordance with the mechanical drawings, control narratives, and P&ID's. Schedules may not be all inclusive.

**END OF SECTION**











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**SECTION 40 73 00**  
**PRESSURE, STRAIN, AND FORCE MEASUREMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section provides requirements for furnishing, installation, and services for pressure measurement instruments as detailed on the Drawings.
- B. Instrument Schedules have been provided at the end of the specification section. Schedules may not be all inclusive. Refer to P&IDs and Mechanical sheets for instruments to be furnished and installed on the project.
- C. Related Sections include but are not necessarily limited to:
  - 1. Division 00 - Procurement and Contracting Requirements.
  - 2. Division 01 - General Requirements.

**1.2 REFERENCES**

- A. Refer to Section 40 61 01 - Instrumentation and Control System References and Abbreviations. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.
- B. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Control System Integrator unless otherwise directed by the OWNER/ENGINEER.

**1.3 ADMINISTRATIVE REQUIREMENTS – NOT USED**

**1.4 SUBMITTALS**

- A. General Requirements: Comply with the submittal requirements of Section 01 30 00 - Administrative Requirements, Section 40 61 00 - Instrumentation and Control System General Provisions, and as described below.
- B. Submit to the ENGINEER the following:
  - 1. Manufacturer's name and address, as well as Manufacturer's product name and complete model number for all equipment and accessories proposed for use
  - 2. Materials of Construction for equipment housing
  - 3. Dimensions
  - 4. Measurement accuracy

5. Measurement range for proposed level measurement system
  6. Enclosure NEMA rating(s) for components
  7. NEC Area Classification for model(s) chosen
  8. Power requirements and consumption in Voltage, Wattage and Amperage
  9. Output options
  10. Parts list for all components in sufficient detail to allow an item-by-item comparison with the Contract documents.
- C. Manufacturer's Instructions for the shipping, handling, storage, installation, start-up, operation, and maintenance, with schedule, of the equipment (in both hardcopy and digital formats). Include spare parts lists, instructions for instrument calibration and programming, instrument testing sheets, and schematics.
- D. Manufacturer's certification of satisfactory installation, calibration, and testing.
- E. Proof of Warranty as indicated.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer:
1. Products:
    - a. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include (unless "No Equal" is quantified), but are not limited to, have been named within the various paragraphs of this Section.
    - b. The listing of specific manufacturers within the various paragraphs of this Section does not imply acceptance of their products that do not meet the specified ratings, features and functions. manufacturers listed within the various paragraphs of this Section are not relieved from meeting these specifications in their entirety.
    - c. Manufacturer of the products under this Section shall be experienced, producing meters that are fully developed, field proven, and of standardized designs.
    - d. To the greatest extents possible, provide equipment that is the product of one (1) manufacturer in order to achieve standardization of operation, maintenance, spare parts, and Manufacturer's service.
  2. Services:
    - a. If indicated in the individual instrumentation paragraphs, the instrument manufacturer or manufacturer's certified service representative shall provide start-up and training services. This work shall not be done by the CONTRACTOR or Control System Integrator.
    - b. The start-up services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter in order to provide reliable measurement at the instrument and to a remote system. The vendor shall work with the Control System Integrator to verify the transmitter sends correct information to the remote system (i.e., that the scaling and units are the same at the instrument and on the remote operator interface).

- c. While the instrument manufacturer or manufacturer's certified service representative is starting up the instrumentation, training shall be provided to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.
- d. An authorized Manufacturer's representative shall inspect the installation of all work furnished in this Section and shall provide a Manufacturer's certificate showing that the equipment has been satisfactorily installed, calibrated, and tested.

B. Installer:

- 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.
- B. The Contractor shall be responsible for replacing, at his expense, instruments that are not stored in strict conformance with the Manufacturer's recommendations.

### 1.7 SITE CONDITIONS

A. Operating Conditions:

- 1. Ambient Conditions: Provide equipment suitable for ambient conditions in accordance with environment requirement paragraphs specified below.
- 2. Field Locations: Field equipment may be subjected to ambient temperatures from 0-120° F, with direct radiation, and relative humidity from 45 to 96% with condensation. Field equipment will also experience rain, freezing rain, and snow.
- 3. Power Supply: Power supply will be 120 Vac, single-phase, 60 Hz commercial power. Voltage variations will be at least plus or minus 8%. Certain loops shall have integral power supply as indicated on the drawings.
- 4. Standard Signal:
  - a. Output Signal. Each instrument, which outputs a signal, shall output the standard 4-20 mA signal. The signal shall be constant over a load range of 0-600 Ω.
  - b. Input Signal.
    - 1) Electronic devices, such as controllers, match function devices, etc., shall have an input impedance of one mega-ohm minimum for an input signal of 1-5 Vdc.
    - 2) The 1-5 Vdc signal shall be developed by the standard 4-20 mA transmitted signal through a precision 250 Ω, 1 W resistor.
    - 3) These requirements allow several receiving units to monitor the same transmitting unit without causing any perturbation of the received signal.
    - 4) Receiving devices shall not be wired in parallel.

B. Components, Hazardous Area Location:

1. Assure equipment located in hazardous areas is suitable for applicable classification by use of explosion-proof housings or equipment and barriers approved as "intrinsically safe" by either UL or FM.
  2. Locate barriers in cabinets at hazardous area boundaries. Use dual barriers in loops in order to prevent grounding loop at the barrier.
- C. Components, Submerged Locations:
1. Those instruments that are submerged in a liquid or are located in submersible area shall meet NEMA 6P ratings approval

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the control system that fail(s) in materials or workmanship within the specified warranty period.
1. Warranty Period: Two (2) years from the date of completion of the Site Acceptance Test.
  2. Cost for the removal, shipment, repair or replacement, and installation of components by CONTRACTOR shall be included in the warranty, as well as replacement of defective work.

## PART 2 - PRODUCTS

### 2.1 LIQUID FILLED PRESSURE INDICATING DIAL GAUGE

- A. Gauge shall be C-type Bourdon tube.
- B. Manufacturers:
1. Ashcroft
- C. Requirements:
1. Function/Performance:
    - a. Range: Range of the gauge shall be the standard range of the manufacturer closest to the pressure range to be metered.
    - b. Accuracy: 1 percent of full scale
    - c. Operating Temperature: -40 to 140 degrees C.
  2. Physical:
    - a. Measuring Element: 316 stainless steel C-Type Bourdon tube
    - b. Connection: 1/2" NPT, 316 Stainless Steel
    - c. Case: 304 Stainless Steel with safety relief plug
    - d. Cover Ring: Polished 304 stainless steel
    - e. Lends: Instrument glass
    - f. Pointer: Black finished aluminum
    - g. Dial: 4" or 4 1/2" aluminum, white background with black scale, single scale UV resistant.
    - h. Fill Liquid: Glycerin
- D. Accessories Required:

1. When required by detail, provide a 316 stainless steel block & bleed shut off valve. Valves may be mounted directly to the instrument or separately mounted.
2. Diaphragm seals or pressure seal rings shall be provided when shown Drawings or indicated in Instrument Schedule.

## 2.2 UNSCHEDULED DEVICES

- A. Hand Valves: Provide process valves at all process taps for isolation of instrumentation equipment except where safety would be compromised by their use. Valves must provide straight-through passage and tight shutoff to the rating of the valve.
1. Water Service: Fluid pressure below 200 psig and fluid temperature below 300°F, provide 3/4-inch ball valve with stainless steel swagelok body, disc, union bonnet, and TFE impregnated non-asbestos packing.
    - a. manufacturers:
      - 1) Crane No. 431 UB.
      - 2) Whitney; Series 41 through Series 43.
  2. Valve, Needle: Stainless steel body with 0.020 orifice.
    - a. manufacturers and Products:
      - 1) Hoke; 3700 Series.
      - 2) Whitney; Model 21RF2.
  3. Regulating Valves: Provide stainless steel needle valves, with regulating stems and screwed bonnet.
    - a. manufacturers and Products:
      - 1) Whitney; Catalog No. RF or RS.
      - 2) Hoke; 3100 through 3300 Series.
- B. Tubing, Stainless Steel:
1. Tubing: ASTM A269, Grade TP304.
  2. Compression Fittings: ASTM A269, Grade TP316.
- C. Instrument Manifolds:
1. Provide instrument manifolds for all static pressure, liquid level and differential pressure applications.
  2. Provide 2-valve manifolds for static pressure and liquid applications. Provide 5- valve manifolds for differential pressure applications.
  3. Materials: 316 stainless steel construction.
  4. Block and Bleed Valves: Stainless steel needle valves with PTFE packing material.
  5. Manufacturer and Product: Swagelok; V, VB and VL Series.
- D. Diaphragm Pressure Seals:
1. Provide diaphragm pressure seals when indicated in contract documents.
  2. Wetted Materials; Diaphragm and Bottom Housing Compatible with fluid being sensed.
  3. Fill Solution; Compatible with application.
  4. Manufacturer and Product: Omega; 100, 102 and 202 series.

- E. Pressure Sensor Rings:
  - 1. Provide pressure sensor rings when indicated in contract documents.
  - 2. Pressure sensor rings shall be full flange design, to be retained between standard ANSI B16.1 Class 125/6.5 Class 150 pipe flanges. Sensor shall be flow through design with flexible.
  - 3. Materials; Sleeves and Fill Fluid; Compatible with application. elastomer sensing ring around the full circumference.
  - 4. Manufacturer and Product: Red Valve Co.; Series 40.
- F. Instrument Nameplates
  - 1. Component identification for field devices:
    - a. Inscription: Component tag number.
    - b. Materials: 16-gauge, Type 304 stainless steel.
    - c. Letters: 3/16-inch imposed.
    - d. Mounting: Affix to component with 16 gauge or 18-gauge stainless steel wire or stainless steel
  - 2. Panel Face: Component identification located on panel face under or near component.
    - a. Locations and Inscription: As shown.
    - b. Materials: Laminated plastic attached to panel with stainless steel screws.
    - c. Letters: 3/16-inch white on black background, unless otherwise noted.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordination: Coordinate equipment delivery with completion of other work to minimize field handling of each device.

### 3.2 INSTALLATION

- A. General Requirements:
  - 1. Examine contract drawings and shop drawings for equipment in order to determine best arrangement for work as a whole.
  - 2. Mount pipe, and connect field devices in accordance with contract drawings, specification and manufacturer's installation instructions.
  - 3. Avoid tubing, piping and conduit interferences.
  - 4. Locate equipment to be accessible for operation, maintenance and replacement.
  - 5. Mount field transmitters 40 inches above floor, work platform, or as sensing line slope requires per manufacturer's instructions and in a location to allow convenient access for readability, calibration and maintenance. Coordinate tap location and meter location with ENGINEER prior to beginning work.
- B. Device Mounting and Location Requirements.
  - 1. Where specifications and contract drawings do not delineate precise installation procedures, use API RP550 as a guide to installation procedures. Submit sketch for OWNER approval prior to installation.



2. Locate field-mounted instruments as shown on drawings or as designated by the OWNER's representative or ENGINEER.
3. Secure support pipes, stands or brackets of material with sufficient strength to prevent excess vibration or movement.
4. Where field devices are shown as yoke mounted on a floor stand, a wall bracket fabricated from two channel sections, 1 5/8 inches sized, mounted to a wall or column is considered equal.
5. Make channel section long enough to mount at least two field devices. Use aluminum or stainless steel for fabrication.
6. Locate instrument-mounting stands within 5 feet of primary element, unless otherwise indicated. Make stands freely accessible.
7. Locate indicating instruments which must be visible for automatic control adjustment or manual operation to be visible from the adjustment or operating point. If plot or piping arrangement precludes this, make other provisions for indication at the adjustment or operation point.
8. Install instrument mounting stands after all conduit and pipe has been installed, except conduit serving devices on stand.
9. Install instrument process piping and tubing from each primary shutoff valve to appropriate gauge, sensor, meter, analyzer, control panel connections, etc.
10. Clean piping, tubing and components thereof prior to installation. This shall include but is not limited to special cleaning procedures for oxygen service when so required.
11. Adjust pulsation dampers to eliminate rapid fluctuations of gauge or switch but to retain sensitivity to pressure changes.

### 3.3 COMMISSIONING

#### A. Commissioning:

1. Commissioning of instruments shall be in accordance with manufacturers' instructions, the product data and shop drawings, Section 40 61 00 - Instrumentation and Control System General Provisions.

#### B. General Requirements

1. Notify the OWNER/ENGINEER in writing at least 24 hours in advance of any test. All tests executed without such notification are invalid and shall be repeated. The OWNER/ENGINEER reserves the right to witness any test, inspection, calibration or start-up activity.
2. Perform commissioning of each device, subsystem and system under direct supervision of the individual manufacturer's factory-trained representative.
3. Reports:
  - a. Prepare Report showing test procedures, conditions and results of each test. In the test report, give applicable contract requirements, manufacturer's performance specifications, and permissible tolerances at each test point, actual values of test signals and actual values of test results.
  - b. Check off List:
    - 1) Maintain a check off list by loop number indicating tasks remaining to be done to make loop operational.

- 2) Submit check off list form at least 60 days before commissioning starts.
- 3) Submit check off lists when requested by OWNER/ENGINEER.
- 4) Lists will be requested no more frequently than once a week.

### 3.4 TESTING AND TRAINING

- A. Testing: Accomplished in accordance with the requirements of Section 40 61 21 - Instrumentation and Control System Testing and Commissioning and Section 01 70 00 - Execution and Closeout Requirements.
- B. Training: Accomplished in accordance with the requirements of Section 40 61 26 - Instrumentation and Control System Training and Section 01 70 00 - Execution and Closeout Requirements.

### 3.5 INSTRUMENT SCHEDULES

- A. Provide field instruments, as listed in the Instrument Schedules after END OF SECTION, of the range, type, in accordance with the mechanical drawings, control narratives, and P&ID's. Schedules may not be all inclusive.

**END OF SECTION**



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**SECTION 43 05 25  
COMMON REQUIREMENTS FOR PUMPS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

A. Scope of Work:

1. This Section provides requirements common to the pumping unit specification sections of Division 43. In addition to the specific requirements of the individual pumping unit specification sections. The CONTRACTOR shall be responsible for ensuring all pumping units comply with the requirements of this Section. The detailed equipment specifications shall govern where this section conflicts with detailed sections.
2. CONTRACTOR shall furnish and install all tools, equipment, materials, and supplies and shall perform all labor necessary for the installation, testing, and placing into operation of all pumps and pumping appurtenances, complete and operable, in accordance with the requirements of the Contact Documents.

B. Related Sections:

1. Division 40 Section 40 05 00 General Requirements for Plant and Station Piping Systems” for basic piping requirements associated with equipment systems, along with the individual piping sections.
2. Division 40 Section 40 12 16.40 “Miscellaneous Valves and Appurtenances” for basic valve requirements associated with equipment systems, along with the individual valve sections.
3. Division 43 Section 43 25 13 “Submersible Centrifugal Pump” for specific pump requirements.

**1.3 REFERENCES**

A. Reference Specifications, Standards, Codes, and Regulations:

1. Various Project sections contain references to specifications, standards, codes, regulations, and other documentation and shall be considered a part of those sections as specified and modified.
2. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly.
3. In the event of conflict between the requirements of the Project specification sections and those of the listed documents, the requirements of the Project specification sections shall prevail.
4. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Opening of Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was

discontinued.

- B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications.
1. American Society for Testing and Materials (ASTM).
  2. American Public Health Association (APHA).
  3. American National Standards Institute (ANSI).
  4. American Society of Mechanical Engineers (ASME).
  5. American Water Works Association (AWWA).
  6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
  7. American Welding Society (AWS).
  8. National Fire Protection Association (NFPA).
  9. Federal Specifications (FS).
  10. National Electrical Manufacturers Association (NEMA).
  11. Rubber Manufacturers of America (RMA).
  12. Manufacturer's published recommendations and specifications.
  13. General Industry Safety Orders (OSHA).
- C. The following standards are referred to in the various Project specification sections:
1. American National standards Institute (ANSI):
    - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250.
    - b. B16.5 – Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys.
  2. American Society of Mechanical Engineers (ASME):
    - a. B31.3 – Process Piping
  3. ASTM International, Inc. (ASTM):
    - a. A 48 – Specification for Gray Iron Castings
    - b. A 470 – Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts.
    - c. A 536 – Specification for Ductile Iron Castings.
    - d. E 448 – Standard Practice for Scleroscope Hardness Testing of Metallic Materials.
    - e. B 62 – Specification for Composition Bronze or Ounce Metal Castings.
  4. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps.
  5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. 112 – Test Procedure for Polyphase Induction Motors and Generators.
    - b. 115 – Test Procedure for Synchronous Machines.
  6. National Electrical Manufacturer's Association (NEMA): MG-1, Motors and Generators.
  7. National Fire Protection Association (NFPA): NFPA 70, National Electric Code.
  8. National Sanitation Foundation (NSF): NSF 61, Drinking Water Components – Health Effects.

## 1.4 SUBMITTALS

- A. The information requested in the various Project specification sections shall be prepared and submitted in accordance with the requirements described in the following paragraphs.
- B. Equipment and Related Lists: Lists are included for the convenience of the ENGINEER and CONTRACTOR and are not complete listings of all pumps, equipment, devices and material to be provided under this Contract. The CONTRACTOR agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of the Project.
- C. Manufacturer Installation Instructions: Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the pumping units.
- D. Pump Submittal Requirements: Following are supplemental requirements for pumping unit submittals.
  - 1. Manufacturer to indicate points on the head/capacity curves, and the limits recommended for stable operation which the pumps may be operated without surge, cavitation and vibration. The stable operating range shall be as wide as possible based on the pumps actual hydraulic and mechanical tests.
  - 2. Pump detailed description and specification.
  - 3. Electrical data, including power, signal, and control wiring diagrams, with terminals and numbers.
  - 4. Assembly drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions and shipping weights.
  - 5. Installation drawings including manufacturer's recommended dimensions and spacing of the anti-vortex baffling underneath and between each pump, and pump shelf (if needed). The installation drawings shall also include the installed pump positioning taking into account the actual dimensions of the pump, base elbow, discharge piping, guide rails, and guide bar bracket to ensure the pump can be pulled without interference from the discharge piping and pump hatch.
  - 6. Bearing life calculations.
  - 7. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and include any motor specifications.
  - 8. Documentation demonstrating factory finish is equivalent to finish system specified in this Section.
- E. Information Submittals:
  - 1. Manufacturer's Certification of Compliance.
  - 2. Special shipping, storage and protection, and handling instructions.
  - 3. Manufacturer's Instructions for installation.
  - 4. Manufacturer's Certificate of Proper Installation.
  - 5. Qualification Data: For manufacturer and manufacturer's representative.
  - 6. Suggested spare parts list to maintain the equipment in service for a period of two years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current pricing information.
  - 7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

8. Warranties and service agreements.
  9. Design calculations for pump base and anchorage signed and sealed by a Professional Engineer.
- F. Operation and Maintenance Data: For each pumping system to include in operation and maintenance manuals in accordance with Division 1 Section 01 78 23 "Operation and Maintenance Data."
- G. Guarantees and Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the pumping units will operate within the published efficiencies, heads, and flow ranges and meet these specifications.

#### 1.5 QUALITY ASSURANCE

- A. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine.
- B. Manufacturer Qualifications: Unless otherwise specified in the individual specification sections;
1. All equipment shall be the product of a manufacturer which has been in the design, fabrication, assembly, testing, start-up and service of full scale pumping units with at least fifteen (15) North American installations of the type, model, and size specified for a period of not less than five (5) years prior to the bid date of this Contract.
  2. A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts.
  3. Certified to ISO 9001 by an accredited certification agency.
- C. Installer Qualifications:
1. Unless otherwise specified in the individual specification sections; CONTRACTOR shall provide a manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
  2. Manufacturer's representative shall be provide for each pumping unit, 10 Hp and larger for the periods indicated in the individual specification section.
- D. Source Limitations: Pumping units of each type specified as specified in the individual specification sections shall be supplied by a single manufacturer. This does not require that all equipment be manufactured by a single manufacturer, but does require that the manufacturer of the system shall be responsible for the complete system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle and store equipment components in accordance with shop drawings, and manufacturer's written instructions.
- B. Special requirements for the storage and handling of pumping units will be provided in the specified pumping unit section.

#### 1.7 PROJECT CONDITIONS

- A. Structural Performance: All equipment, supports, anchors and fasteners shall be of



- adequate size and strength to withstand loads associated with starting, turbulence, debris, thrusts from liquid movement, thermal expansion and contraction, vibration, and other loads encountered under operating conditions.
- B. Operation: Equipment shall be designed and capable of either continuous or intermittent operation.
  - C. System Arrangement:
    - 1. The equipment, sizes, materials, and arrangements described in the individual specification sections are typically based on recommendations by equipment manufacturers and shall be considered minimum limits of acceptability. The equipment MANUFACTURER shall be responsible for design, arrangement, and performance of all equipment supplied under this section.
    - 2. Modifications to structural design due to a manufacturer's varying space requirements, foundation requirements, floor slope requirements, dimension changes, or other requirements to fit manufacturer specific requirements shall be coordinated by CONTRACTOR and included in the Bid.
    - 3. The CONTRACTOR shall be responsible for any modifications to the piping, electrical, structural, and mechanical layouts to accommodate, as well reimbursement to OWNER for additional charges by ENGINEER for additional work required for accomplishing the changes.
  - D. Environmental Conditions:
    - 1. All equipment, including controls and drives specified herein, shall be specifically designed for the service and the environment to be encountered.
    - 2. When installed in wastewater treatment areas, the environment will be moist, and corrosive, exhibiting hydrogen sulfide and other corrosive gases encountered in municipal wastewater treatment plants.
    - 3. Designed and capable of operation at ambient temperatures of 0°F to 110°F.
    - 4. Furnish heat tracing and insulation as required, if required for exterior installation. Insulation alone shall not be sufficient to fulfill freeze protection provisions of this section.
  - E. Field Measurements, Existing Facilities Installation: Verify actual dimensions of openings, adjacent facilities and equipment, utilities and related items by field measurements before fabrication as applicable.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail(s) in materials or workmanship within specified warranty period.
  - 1. Standard Warranty Period: Two (2) years from date of Final Completion. Standard warranty shall be Non-Pro Rated with unlimited hours of operation.
  - 2. Extended Warranty Period: Required when experience is below requirements stated in Quality Assurance paragraph. Three (3) years starting at the completion of the Standard Warranty Period. Extended Warranty Period may be Pro-Rated.
- B. Cost for the removal, shipment, repair and installation by CONTRACTOR shall be included in warranty, as well as correction of defective work.

## 1.9 SPARE PARTS AND TOOLS

- A. Tools: Provide special tools necessary for maintenance and repair of the pumps shall be furnished as a part of the work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- B. Spare Parts:
  - 1. Refer to the spare parts list in Paragraph 1.7 of Section 43 25 13 Submersible Centrifugal Pumps.
  - 2. Furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER, only, after expiration of the guaranty period.
  - 3. Any spare parts which the CONTRACTOR was permitted to use for startup activities shall be replaced by the CONTRACTOR prior to the OWNER's acceptance of beneficial use of the equipment.
  - 4. During the term of this Contract the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of the approved spare parts, such as part number, interchangeability, model change or others. If the ENGINEER determines that the modified parts are no longer applicable to the supplied equipment, the CONTRACTOR at its expense shall provide applicable spare parts.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The CONTRACTOR shall furnish and install only such equipment as the designated single manufacturer certifies is suitable for use with its equipment and the service conditions.
- B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than five (5) successful installations of its equipment of comparable nature to that offered under this Contract.
- C. All combinations of manufactured equipment which are provided under these specifications shall be entirely compatible, and the CONTRACTOR and the designated single manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements. Each unit of equipment shall incorporate all basic mechanisms, coupling, electric motor or engine drive and unit mounting. All necessary mountings and appurtenances shall be included.
- D. Where two or more units of the same type and/or size of equipment are required, such units shall all be produced by the same manufacturer.
- E. Tolerance: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts.
- F. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following minimum finishes shall be used:
  - 1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces

in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

G. Noise Level:

1. When the equipment is in operation, no single piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure, and the regulatory agency having jurisdiction where the Project is located.

## 2.2 PUMPING UNIT REQUIREMENTS

A. Materials: All materials furnished as part of the pumping equipment shall be suitable for its intended use and service. Materials not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and, unless otherwise specified in the individual specification section, shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48, or equal.
2. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.
3. All anchor bolts, nuts and washers shall be Type 316 stainless steel, unless otherwise specified.
4. Buried or submerged bolts, nuts and washers shall be Type 316 stainless steel.

B. Bearings: Unless otherwise specified, bearings shall comply with the requirements listed below.

1. Be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified.
2. Rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings.
3. Have a minimum L-10 rating life of 100,000 hours. The rating life shall be determined using the maximum equipment operating speed.
4. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.
5. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60° C and equipped with a filler pipe and an external level indicator gage.

C. Couplings:

1. General: Pumps with a driver greater than 1/2 HP, and where the input shaft of a

driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling.

2. Requirements:
  - a. Accommodate angular misalignment, parallel misalignment and end float, and cushions shock loads and dampens torsion vibrations.
  - b. Consist of a tire with synthetic tension members bonded together in rubber; flexible member attached to flanges by means of clamping rings and cap screws; and flanges attached to the stub shaft by means of taperlock bushings which provide the equivalent of a shrunk-on fit.
  - c. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.
  - d. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, provide Thomas-Rex, Falk Steel Flex, or equal couplings will be acceptable.
- D. Flanges: Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.
- E. Lubrication:
  1. Vertical pump shafts shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals.
  2. For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inch and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of bottom bearing.
- F. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- G. Vortex Suppressors: Vertical pumps with insufficient submergence shall be furnished with vortex suppressors.
- H. Drains: All gland seals, air valves, and cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.
- I. Seals: Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. Unless specified otherwise, stuffing boxes and mechanical seals shall be selected for highest reliability and for rugged service, conforming to the requirements set forth in this paragraph.
  1. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application.
    - a. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.
    - b. Description: Stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing.
    - c. Stuffing boxes shall be face attached.

- d. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified above for the applicable pump and operating conditions.
  - e. Lantern Rings: Bronze or Teflon, two-piece construction, and provided with tapped holes to facilitate removal.
  - f. Packing: Unless otherwise specified, the packing material shall be die-molded packing rings of interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following specification:
    - 1) Shaft speeds - up to 2500 fpm
    - 2) Temperature - up to 500 degrees F
    - 3) pH range - 0-14
  - g. Glands: Bronze, two piece split construction.
  - h. Impeller end of the packing on all but line-shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
2. Mechanical Seals:
- a. Description: Mechanical seal shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area.
  - b. Mechanical seals shall be the split cartridge type, requiring no field assembly, other than assembly around the shaft and insertion into the pump. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastalloy C.
  - c. Rotary Faces: Ceramic or silicon carbide.
  - d. Stationary Faces: Ceramic, tungsten carbide, or silicon carbide.
  - e. Elastomers: Ethylene propylene or fluorocarbon.
  - f. Service Operation: Full vacuum to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.
  - g. Unless otherwise specified, mechanical seals for pumping equipment shall be self-aligning, self-centering, single, Chesterton 442, AES or equivalent.
  - h. Mechanical seals for all pumps (except lineshaft pumps where the seal barrier fluid is used for lineshaft bearing lubrication) shall be fitted with SpiralTrac Version F, N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
  - i. Unless the pump manufacturer recommends a better seal for a specific application, the following mechanical seals shall be furnished with the pumps:
 

Sewage, Sludge, or Wastewater Pumps:	Double seals
-----------------------------------------	--------------
  - j. For all seal arrangements, a buffer fluid must be circulated a minimum 20 psi above suction pressure, or as required by manufacturer, in order to maintain reliable seal performance.
3. Shaft Sleeve:

- a. Section of shaft or impeller hub extending through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve, having a Brinell hardness of not less than 500.
- b. Sleeve held to the shaft to prevent rotation and gasketed to prevent leakage between the shaft and the sleeve.
- c. Minimum shaft sleeve thickness shall be 3/8 inch.

## 2.3 PUMP APPURTENANCES

- A. **Manufacturer Nameplate:** Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, manufacturer's name and model number, and other appurtenant information.
- B. **Equipment Identification Plates:** A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear 1/4-inch die-stamped equipment identification number indicated in this Section and/or on the Drawings.
- C. **Lifting Lugs:** Individual equipment and/or each field disassemble part weighing over 80 pounds shall be provided with lifting lugs
- D. **Anchor Bolts:** Provide template and Type 316 stainless steel anchors as shown on the Drawings. Size and embedment of anchor bolts shall be designed by the pump manufacturer.
- E. **Initial Supply of Lubricants:** Manufacturer shall indicate types, brands, and quantities of initial lubricants, oil, grease, etc. necessary to startup equipment. CONTRACTOR shall provide and install the recommended lubricants and shall comply with all manufacturer recommended procedures.
- F. **Solenoid Valves:** The pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from motor control panel to solenoid.
- G. **Pressure Gages:** Gage taps shall be provided on the suction and discharge sides of pumps (except sample pumps, sump pumps, and hot water circulating pumps) and shall be equipped with pressure gages installed at pump suction and discharge lines.
  1. Pressure gages shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
  2. Pressure gauges shall be furnished in conformance with Division 40 Section 40 73 13 "Pressure Gauges".
  3. Pump suction shall be equipped with compound gages. Where subject to shock or vibrations, provide a snubber, which is wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
- H. **Guards:** Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of minimum 14-gage galvanized steel or fiberglass; designed to be readily removable to facilitate maintenance of moving parts.
- I. **Safety Signs:** Provide the following safety signs in accordance with Division 10 Section 10 14 00 "Signs":
  1. Equipment with guarded moving parts which operates automatically or by remote

control shall be identified signs reading "CAUTION - EQUIPMENT STARTS AND STOPS AUTOMATICALLY."

2. Place a caution sign on the guard reading "CAUTION- KEEP GUARD IN PLACE."

## 2.4 SOURCE QUALITY CONTROL

- A. CONTRACTOR shall be responsible for the coordination of the following tests of each of each pump, drive, and motor:
  - B. General: Tests shall be performed in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute. Tests shall be performed on the actual assembled unit from shut-off head condition to 150 percent of the required maximum design capacity. Prototype model tests will not be acceptable.
  - C. Factory Tests of Pumps:
    1. All pumps and motors of sizes 10 to 125 hp (inclusive) shall be factory-tested in accordance with the above specifications. Submit the Certified test data to the ENGINEER. This data shall include, but not be limited to the following:
      - a. Hydrostatic test with data recorded. Pump casing tested at 150 percent of shutoff head. Test pressure maintained for not less than five minutes.
      - b. Hydraulic test with a minimum of 5 readings between shutoff head and 125 percent of the maximum design capacity, recorded on data sheets as defined by the Hydraulic Institute, signed, dated, and certified.
      - c. Certified pumps curves showing head/flow, bhp, efficiency, [NPSH] curves. [NPSH required shall be at least 5 feet of water absolute less than NPSH available.]
      - d. Certification that the pump hp demand will not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
    2. Vibration Test: Dynamically balance rotating parts of each pump and its driving unit before final assembly. Limits; Complete rotating assembly, including drive unit and motor, shall be less than 90 percent of limits established in the Hydraulic Institute Standards.
  - D. Factory Tests of Motors: All motors of sizes 10 hp and larger, shall be assembled, tested, and certified at the factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 and ANSI/IEEE 115 standards, including heat run and efficiency tests. All computations shall be recorded and provide certified and dated copies of the test results to the ENGINEER.
  - E. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger, shall be factory-tested as complete, assembled units, as specified above, and witnessed by the ENGINEER and the OWNER.
    1. Manufacturer shall provide the ENGINEER a minimum of two (2) weeks notification prior to the test.
    2. All costs for OWNER and ENGINEER shall be borne by the CONTRACTOR and included in the bid price. Such costs shall include travel and subsistence for two people but shall exclude any salaries. Provide copies of the test results to the ENGINEER and no equipment shall be shipped until the test data have been approved.
  - F. Acceptance: In the event of failure of any pump to meet any of the individual section requirements or efficiencies, the CONTRACTOR shall make all necessary modifications,

repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be factory re-tested at no additional compensation, until found satisfactory.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Install and adjust equipment in accordance with the Drawings, approved shop drawings, and the manufacturer's instructions. Do not operate the equipment until the installation is approved by the manufacturer's representative.

#### 3.2 INSTALLATION

- A. Assemble and install equipment in accordance with the manufacturer's instructions and the following:
  - 1. Support all piping independently of the pump.
  - 2. Level baseplate by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4-inch per foot. Use double wedges to provide a level bearing surface. Accomplish wedging so that there is no change of level or springing of the base elbow when anchor bolts are tightened.
  - 3. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
  - 4. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout of the proper category, as specified in Division 3 Section 03 60 00 "Grout, Non-Shrink." Remove wedges after grout is set and pack void with grout.
  - 5. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions. Turn rotating equipment by hand to check. Complete cleaning and testing of piping systems. Inspect and clean equipment, devices, piping, and structures of debris and foreign material.
  - 6. Remove temporary bracing supports and other construction debris that may damage equipment.
  - 7. Remove protective coatings and oils used for protection during shipment and installation.
  - 8. Flush, fill, and grease lubricated systems in accordance with manufacturer's instructions.
- B. Seal Water Connections: Provide seal water piping, valves, flow indicator, pressure and flow control devices, to pump packing for units handling slurries, grit, water containing sand or solids, and as specified in the drawings in accordance with the Standard Details.
- C. Base Plate Drains: Provide drain line from pumping unit base to the floor drain.
- D. Install temporary connections and devices required to fill, operate, checkout and drain the system. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment necessary to conduct testing and startup.
- E. Equipment



1. Check equipment for correct direction of rotation and freedom of moving parts.
  2. Align equipment to Manufacturer's tolerances. Adjust clearances and torques.
  3. Check installation prior to start-up for conformance to manufacturer's instructions.
  4. Adjust or modify equipment to ensure proper operation.
- F. Correct any deficiencies or problems noted in manufacturer's representative's installation reports.

### 3.3 PROTECTIVE COATING

- A. Provide polyurethane, pigmented (over epoxy zinc rich primer and high build epoxy) in accordance with Division 9 Section 09 91 00 "Painting and Protective Coatings." Pump shall receive surface preparation, prime coat and finish coat in factory.
- B. Shop painted items which suffered damage to the shop coating shall be touched up as specified in Division 9 Section 09 91 00 "Painting and Protective Coatings."

### 3.4 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump as described below and in accordance with Division 1 Section 01 75 00 "Equipment Testing and Startup".
1. Pumping units shall be field tested after installation, to demonstrate satisfactory operation, without causing excessive noise, vibration, cavitation, and overheating of the bearings.
  2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
  3. Vibration Test:
    - a. Test units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual facility structures and foundations provided, shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes exceeding the limits specified.
    - b. Any vibration shall be within the amplitude limits recommended in the Hydraulic Institute Standards and it shall be recorded at a minimum of four (4) pumping conditions defined by the ENGINEER.
    - c. If units exhibit vibration in excess of the limits specified adjust, or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
    - d. Flow Output: Measured by plant instrumentation and storage volumes.
- B. Performance Test: In accordance with Hydraulic Institute Standards.
1. Place each piece of equipment in the system in operation until the entire system is functioning. All components shall continue to operate without alarms or shut downs, except as intended, for eight consecutive hours to be considered started up.
  2. Operate the equipment through the design performance range. Adjust, balance, and calibrate and verify that the equipment, safety devices, controls, and process system operate within the design conditions.
  3. Each safety device shall be tested for proper setting and signal. Response shall be checked for each equipment item and alarm. Simulation signals may be used to check

- equipment and alarm responses.
4. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head, for at least four (4) pumping conditions at each pump rpm. Each power lead to the motor shall be checked for proper current balance.
  5. Bearing temperatures shall be determined by a contact-type thermometer. A running time of at least 20 minutes shall be maintained for this test, unless liquid volume available is insufficient for a complete test. Bearing temperatures shall not exceed 180°F at any point during the test.
- C. A copy of all information from functional tests, including data, worksheets, and other materials shall be turned over to the OWNER at the completion of the testing program.

### 3.5 MANUFACTURER'S SERVICES

- A. Manufacturers services shall comply with the following:
1. Manufacturer's representative shall be provided present at Project site or classroom designated by OWNER, and depending of the Construction Schedule, provide the number of trips required to provide the minimum person-days listed in the individual specification sections, travel time excluded.
- B. Inspection, Startup, and Field Adjustment: CONTRACTOR shall demonstrate that all equipment meets the specified performance requirements. CONTRACTOR shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment and shall visit the site of work to perform the following tasks.
1. Assist the CONTRACTOR in the installation of the equipment.
  2. Inspect, check, adjust if necessary and approve the equipment installation.
  3. Start-up and field-test the equipment for proper operation, efficiency, and capacity.
  4. Perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the ENGINEER.
  5. Instruct OWNER's personnel in the operation and maintenance of the equipment. Instruction prior to system testing of the equipment shall include step-by-step troubleshooting procedures with all necessary equipment testing.
- C. Manufacture's Certificates:
1. Provide equipment manufacturer's Certificate of Installation stating that the equipment is installed per the manufacturer's recommendations and in accordance with the Drawings and Specifications.
  2. Provide equipment manufacturer's Certificate of Performance stating that the equipment meets or exceeds the performance requirements as defined hereinbefore.

### 3.6 FACILITY STARTUP

- A. Startup of the facility shall be in accordance with Division 1 Section 01 75 25 "Equipment Testing and Startup." After initial startup under the supervision of a qualified representative of the pump manufacturer, a preliminary "running-in" period will be provided for the CONTRACTOR, per the Contract Documents, to make field tests and necessary adjustments. At the end of the specified period of operation, the pumps will be accepted if, in the opinion of the ENGINEER, the pumps have operated satisfactorily without excessive power input,

wear, lubrication, or undue attention required for this operation, and if all rotating parts operate without excessive vibration or noise at any operating speed and head, including shutoff.

**END OF SECTION**

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**SECTION 43 25 13**  
**SUBMERSIBLE CENTRIFUGAL PUMPS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Furnish, install, check-out, start-up, test, place in operation and perform quarterly warranty inspections for the following lift station:
1. Three (3) submersible centrifugal vertical close-coupled sewage pumps with non-clog semi-open multi-vane self-cleaning impellers designed to transport wastewater with fibrous materials, with bottom inlets and side discharge, complete with submersible motors, submersible cables, and all necessary discharge base elbows, guide rail brackets, lifting chain with cable, anchors bolts, and accessories for wet pit operation.
- B. Section Includes:
1. Submersible pumping units.
  2. Discharge base elbow, discharge pipe, guide rails, brackets, lifting chain with cable, anchors bolts, and accessories for wet pit operation.
  3. Control and power cables, cable holder and accessories for wet pit operation.
  4. Installation, startup, testing, and placing in service assistance.
  5. Training of Owner's personnel.
- C. Related Sections:
1. Division 43, Section 43 05 25 - "Common Requirements for Pumps"

**1.3 REFERENCES**

- A. References: Following is a list of standards, which might be referenced in this Section:
1. American Bearing Manufacturer's Association (ABMA):
    - a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
    - b. 11 - Load Ratings and Fatigue Life for Roller Bearings.
  2. ASTM International (ASTM):
    - a. A48 - Specification for Gray Iron Castings.
    - b. A572 - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
  3. National Electrical Manufacturer's Association (NEMA): MG-1, Motors and Generators.
  4. National Fire Protection Association (NFPA): NFPA 70, National Electric Code.

**1.4 COMMON REQUIREMENTS**

- A. Refer to Division 43 Section 43 05 25 "Common Requirements for Pumps" for additional information for pumping units not specified in this Section. CONTRACTOR shall be responsible for ensuring the pumping units comply with the requirements of the referenced

Section, in addition to the specific requirements as specified in this Section.

- B. Refer to the above Section for information regarding the following:
  - 1. Part 1: Submittals; quality assurance; project conditions; coordination; equipment delivery, handling, and storage; project conditions; design requirements; special warranties; and spare parts and tools.
  - 2. Part 2: General requirements for pumping unit components; pump appurtenances; and source quality control.
  - 3. Part 3: General requirements; installation of pumping units; manufacturer's services; field testing; and related work.
  - 4. This Section will provide specific requirements for this Work.

## 1.5 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Summary:
    - a. Provide the following pumping systems at the locations shown on the drawings:
      - 1) Three (3) non-clog, submersible pumps to be installed in the wastewater lift station as shown on the plans.
    - b. Rail and Lifting System: For submersible pump installation provide a rail and lifting system, along with the power and control cables and accessories.
    - c. Refer to P&ID's, Drawings, and Instrumentation Sections regarding the control logic and description for additional pump monitoring and control information as applicable.
  - 2. Equipment shall be designed and capable of both continuous and intermittent wet pit operation as indicated on Drawings. Grit and other abrasive materials should be expected to be present as should rags, large solids and stringy material. The presence of these items will not be considered as abnormal, unanticipated or abusive with regard to the equipment operation and warranty.
  - 3. All equipment supports, anchors and fasteners shall be Type 316 stainless steel and shall be of adequate strength to withstand loads associated with starting, turbulence, thrusts from liquid movement, thermal expansion and contraction and other loads encountered under normal operating conditions.
  - 4. The equipment, sizes, materials, and arrangements described in this specification section are based on recommendations by equipment manufacturers and shall be considered minimum limits of acceptability. The equipment manufacturer shall be responsible for design, arrangement, and performance of all equipment supplied under this section. Arrangements other than those shown on plans shall be subject to ENGINEER's approval.

## 1.6 PERFORMANCE REQUIREMENTS

- A. General Performance:
  - 1. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water to a depth of 65 feet without loss of watertight integrity.
  - 2. Pumping Unit System: Comply with performance requirements specified, as determined by testing assemblies representing those indicated for this Project.
- B. Specific Performance Requirements: Refer to attached Pump Data Sheet after "END OF

## SECTION".

### 1.7 SPARE PARTS AND TOOLS

- A. The following spare parts shall be furnished for each size of pump provided under this specification:
  - 1. Mechanical seal or seal repairs kit with all seal faces and O-rings.
  - 2. Upper and lower bearings set.
  - 3. Special tools required for maintenance or adjustment.
  - 4. Other items as recommended by manufacturer.
- B. Furnish three (3) sets of spare parts for the lift station pumps.

### 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail(s) in materials or workmanship within specified warranty period.
  - 1. Standard Warranty Period: Two (2) years from date of Final Completion. Standard warranty shall be Non-Pro Rated with unlimited hours of operation. The cost of removal, shipment, repair, and installation by CONTRACTOR shall be included in the warranty and correction of defective work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Flygt Corporation
  - 2. Flowserve
  - 3. KSB

### 2.2 PUMP CONSTRUCTION DETAILS

- A. Type: Vertical, non-clogging, centrifugal sewage pump with bottom inlet and side discharge; direct driven by integral squirrel cage, electric induction motor. Pumping system shall include pump, motor, bearings, quick removal system, anchor bolts and all accessories specified herein.
- B. Casing, Volute, and Stator Housing:
  - 1. Gray cast iron, ASTM A48, Class 30, Class 35B, or Class 40B, capable of prolonged resistance to raw sewage.
  - 2. Suction and discharge flanges shall be 125 lb and meet ANSI Standard B16.1.
  - 3. All nuts, bolts, washers, and other fastening devices supplied with pumps shall be stainless steel.
  - 4. Mating surfaces requiring watertight seal shall be machined and fitted with Buna-N O-rings. Paper gaskets, elliptical O-rings, grease, or other devices will be acceptable.
- C. Shaft:
  - 1. Stainless steel; ASTM A 276, Type 416 or Type 420, or ASTM A 479, Type 431, with motor and pump shaft of one piece construction without joints or stubs attached.

Carbon steel shafts or shafts with sleeves of any type are not acceptable.

2. Shaft shall be dynamically balanced and shall be amply sized to minimize shaft deflection.
- D. Bearings: Provide minimum of two (2) permanently lubricated bearings consisting of upper radial bearings and lower thrust bearings rated for B-10 life of 50,000 hours in accordance with AFBMA.
- E. Shaft Seal System:
1. A tandem mechanical seal system consisting of two totally independent seal assemblies shall be provided that operate in a lubricant reservoir.
  2. Upper shaft seal consisting of stationary Tungsten carbide ring and rotating carbon ring or a rotating silicon carbide ring and a stationary carbon ring operating in an oil chamber below stator housing.
  3. Lower shaft seal consisting of stationary and rotating Tungsten carbide or silicon carbide rings designed to seal pumped liquid from stator housing.
  4. Each seal shall be held in place by its own independent stainless steel spring system.
  5. Oil chamber shaft sealing system shall be designed to prevent overfilling and to provide lubricant application capability. Provide drain and inspection plugs accessible from the outside.
  6. Seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable.
- F. Impeller:
1. ASTM A 532, Alloy III A, 25% chrome cast iron, 316 stainless steel; solids handling single or double vane non-clog type.
  2. Impeller vane shall be smooth, finished throughout, and free form sharp edges.
  3. Key driven and held to shaft by a streamlined impeller washer and bolt assembly designed to reduce friction in the suction eye of the impeller, such that the impeller cannot unscrew or be loosened by torque either forward or reverse rotation.
  4. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to RC 60.
  5. Capable of passing the specified solid non-deformable sphere size through the bottom inlet between two shrouds as listed in the Pump Parameter Schedule.
- G. Insert Ring:
1. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed.
  2. The insert ring shall be cast of ASTM A 532, Alloy III A, 25% chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.
- H. Drive Motor:
1. Motor Horsepower: As required so the nameplate horsepower rating is not exceeded at any head-capacity point on the pump curve.



2. Operation: Capable of operating with motor exposed to atmosphere and dry (no liquid around stator pump for cooling) for a minimum of ten (10) minutes without damage to motor or seal.
  3. Enclosure: Submersible.
  4. Mounting: Vertical
  5. Motor Design:
    - a. Power Supply: 480V, 3-phase, 60-Hz, unless otherwise indicated on Drawings.
    - b. Squirrel-cage, induction motor, enclosed in a waterproof housing, for submersible application, meeting requirements of NEMA MG 1. Certified for continuous duty with a Service Factor of 1.15.
    - c. Air filled; constructed with moisture-resistant NEMA Class F or H insulation and Class H slot liners; constructed to NEMA B design standards.
    - d. Copper wound stator shall be either double or triple dipped in epoxy enamel and baked to withstand a temperature of 180°C (Class H) as defined in NEMA MG-1. Each winding phase or layer shall be laced with Type H glass lined paper.
    - e. Rotor shall be statically and dynamically balanced after fabrication and utilize aluminum bars and short circuit rings.
    - f. Designed for continuous duty capable of sustaining 8 starts per hour (Unlimited starts with VFD) at a minimum ambient temperature rise of 40°C.
    - g. Motors shall be capable of uninterrupted operation with a voltage drop of 10%.
    - h. Power cables entering the motor shall connect to individual terminal pins, which separates the incoming service from the motor.
    - i. Motor shall bear the Factory Mutual explosion-proof label certifying its use in a Class 1, Division 1, Groups C & D hazardous location.
    - j. Provide lifting eye.
    - k. Cooling system:
      - 1) Provide Type 304 stainless steel motor cooling jacket, encircling the stator housing, to provide for heat dissipation, regardless of the pump installation.
      - 2) The cooling system shall be self-contained, using a closed loop cooling system and coolant to allow for running under full load conditions at 100% duty cycle with the motor exposed to air and/or in liquid temperatures up to 104°F.
      - 3) The internal circulation of the pumped liquid as coolant is not acceptable. The use of fans, blowers or exposed cooling systems is not acceptable.
- I. Motor Protection Devices:
1. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.
  2. The thermal switches and float switch shall be connected to a motor protection relay unit provided by the pump supplier. The motor projection relays shall be mounted in

the enclosures alongside the pump motor controllers.

J. Power and Control Cables:

1. Provide power and control cables in lengths to run un-spliced from the pump to the junction box or pump control panel. Cables shall terminate with conductor sleeves that bundle the entire group of strands of each phase to improve termination at the control panel.
2. The power cable shall be of a shielded design in which an overall tinned copper shield is included and each phase conductor is shielded with an aluminum coated foil wrap. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater, conforming to NEC and ICEA standards for loads, resistance under submersion against sewage, and heat and chemical resistant.
3. Provide stainless steel cable grips for supporting cable at the top brackets.
4. Cable entry seal to be watertight and submersible.
  - a. The cable entry chamber junction shall be separate from the motor chamber. The chamber junction shall be sealed from the motor chamber with a terminal board or the motor leads shall be staggered and sealed in a manner which prevents wicking.
  - b. Type recommended in Factory Mutual Research Corporation for Explosion Proof Certification.

## 2.3 ACCESSORY EQUIPMENT

- A. General Description: Consist of a discharge elbow that mounts in the bottom of the wet pit, a replaceable pump coupling, guide rails and supports, along with hardware required for a complete and operational system. Connections to piping shall be standard ANSI flanges.
- B. Discharge Elbow: Cast iron, ASTM A48, Class 30B or higher; with 125-lb ANSI flanges.
  1. Designed to support full weight of pump, providing a leak proof seal connection.
  2. Pump connection to the base mounted discharge connection shall be automatic when the pump is lowered into place, and shall be easily disconnected without the need for personnel to enter the wet well.
  3. Sealing of pumping unit to discharge elbow shall be accomplished by a simple linear downward motion of the pump.
  4. Provide a sliding guide bracket of Type 304 stainless steel, ductile iron, or cast iron with epoxy coating for each pump as integral part of pump.
  5. Provide Type 316 anchor bolts, size determined by pump manufacturer.
  6. See data sheet and plans for connection type and size.
- C. Pump Coupling: Cast iron construction, located between the pump discharge flange and the vertical face of the discharge base. Designed to seal against the vertical face of the discharge base using either a metal-to-metal contact or replaceable Buna-N compressible seal.
- D. Guide Rail and Pump Lifting Assemblies:
  1. Provide guide rail assemblies, complete with guide rail supports and anchor brackets, as required producing a complete and properly functioning system based on the sump dimensions and geometry as shown on the Drawings.

2. Provide Type 304 stainless steel guide rails supported by Type 316 stainless steel support brackets. Guide rails shall be Schedule 40 pipe. Provide intermediate support brackets for installations deeper than 20 feet. Anchor bolts shall be Type 316 stainless steel.
3. Lower guide rail support shall be integral with pump discharge base.
4. Provide each pump with the indicated manufacturer's accessories as listed below. Type and size shall be as recommended by the manufacturer.
  - a. Upper guide bar holder.
  - b. Electrode device holder.
  - c. Lifting bale (Type 304 stainless steel) for safety cable.
  - d. "Grip eye" pump lifting-chain positive recovery system of sufficient length and capacity for lifting pump from the wet well employing the hoist.
  - e. Intermediate guide bar supports, as required.
- E. Equipment Identification Plate: 16-gauge Type 316 stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

#### 2.4 FACTORY FINISH

- A. Exterior ferrous surfaces shall receive the following Factory applied coating system:
  1. Surface Preparation: Blasting per ISO 12944-4; Standard Cleanliness Grade 2.5; Minimum Peak to Valley Height 70 microns.
  2. Coating System: Manufacturer's standard coating system for the intended service conditions.
  3. Provide touch up coating material, with the pumps, for CONTRACTOR'S use during installation.
- B. Paint bases, piping and other surfaces in accordance with Division 9 Section 09 90 00 "Painting"

#### 2.5 SOURCE QUALITY CONTROL

- A. Factory Tests and Adjustments: Test all pumping units and control panels to be furnished. Include test data sheets, curve test results, performance test logs, certified by a factory test engineer.
- B. Performance Test:
  1. All internal components including the pumps, motors, valves, piping and controls will be tested as a fully assembled, coated, and complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational tests shall simulate actual performance anticipated for the complete station.
  2. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test.
  3. At least one point shall be obtained as near as possible to each specified condition.
  4. Results of the performance test shall be certified by a Registered Professional Engineer and submitted for approval prior to shipment. Upon request from the

engineer, the operational test may be witnessed by the engineer, and/or representatives of his choice, at the manufacturer's facility.

5. The pump test acceptance grade shall be Grade 1U, as defined by the most recent Hydraulic Institute Pump Standard 11.6 "Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests".
- C. Hydrostatic Test: Pump casing tested at 150 percent of shutoff head. Test pressure maintained for not less than five minutes.
- D. Control Panels: If supplied by manufacturer, factory testing of the completed control panels shall be accomplished by the manufacturer prior to shipment.

### PART 3 - EXECUTION

#### 3.1 FIELD QUALITY CONTROL

- A. Refer to Section 43 05 25 "Common Requirements for Pumps".

#### 3.2 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Project site or classroom designated by OWNER, for minimum person-days listed below, travel time excluded:

No. Person Days	Work Description
1	Installation assistance and inspection.
1	Functional and performance testing.
1/4	Pre-startup classroom or site training.
1	Facility startup.
1/4	Post-startup training of OWNER'S personnel.
4	Post-startup quarterly warranty inspections (8).

- B. Manufacturer shall perform quarterly visits to perform warranty inspection of each installed pump, including but not limited to, amperage, flow and pressure, and motor protection devices components (seal failure and winding thermal sensors) from beginning of warranty period described in Section 43 05 25 and ending at the end of the warranty period.

#### 3.3 SUPPLEMENT

- A. The Pump Data Sheet included after "END OF SECTION" shall be part of this section.

**END OF SECTION**

**PUMP DATA SHEET  
SUBMERSIBLE CENTRIFUGAL PUMP**

<b>Equipment Tag Number(s)</b>	PMP-101, PMP-102, PMP-103 <sup>1</sup>
Quantity	3
Pump Name	See Note 1
<b>Type</b>	
<b>Service Conditions</b>	
Liquid Pumped	Wastewater
Liquid Temperature, deg F	Max: 100 Min: 60
Largest Diameter Solid Pump shall be capable of Passing, inches	3"
Abrasive (Y/N)	Y
Possible Scale Buildup (Y/N)	Y
Explosion-proof (Y/N)	Y
Continuous Duty (Y/N)	Y
<b>Performance Requirements</b>	
Capacity at Primary Condition of Service, gpm	90
Total Head at Primary Condition, Ft.	38
Minimum Wire to Water Efficiency at Primary Condition, %	40
Capacity at Secondary Condition of Service, gpm	170-200
Total Head at Secondary Condition, Ft.	28
Shutoff Pressure, Minimum, Ft.	46
Pump Speed, Maximum, rpm	1,800
Motor HP, Minimum	7.5
Constant Speed (Y/N)	N
Adjustable Speed (Y/N)	Y
<b>Construction Details and Accessories</b>	
Suction (Size, Rating, Facing)	3"
Discharge Base Elbow (Size, Rating, Facing)	3"
Hydrostatic Test Pressure (psig)	1.5 times shutoff head
Field Testing (Required/Not Required)	Required
Control Panel (Y/N)	N
Cooling System Required (Y/N)	Y

NOTES

1. Coordinate with Owner for equipment tag numbers and pump name.
2. Contractor shall coordinate with pump manufacturer to confirm hatch clear opening size and hatch location to allow for pump manufacturer's recommended pump clearance through hatch. Pump removal shall be achievable without rotating pump or disconnecting prematurely from guide rails.

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**SECTION 44 31 66**  
**ODOR CONTROL SYSTEMS EQUIPMENT - WET WELL WIZARD**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes the furnishing of an odor control system for the Existing Site Lift Station:
  - 1. This specification shall govern supplying Wet Well Wizard systems, including all associated equipment and incidentals for installation. The system shall be a Reliant Water Technologies Wet Well Wizard. It shall consist of at least three major parts, with specific fitting hardware, for the purpose of aerating and vigorously agitating lift station wet well on a continuous basis.
  - 2. EQUIPMENT SUPPLIER shall provide installation guidance and assistance to the CONTRACTOR during equipment installation, check-out, startup, testing and commissioning of the Wet Well Wizard.
  - 3. All equipment, material, parts, and accessories to be provided as part of this specification shall be new and free from any defects. The Contractor shall be responsible for the inspection of all equipment prior to installation and shall be responsible for replacement at no additional cost to the owner.
  
- B. Related Sections:
  - 1. Division 0
  - 2. Division 1
  - 3. Section 40 05 05 "Piping System, Basic materials and Methods."
  - 4. Section 40 05 07 "Hangers and Supports for Piping Systems."
  - 5. Section 40 05 93 "Common Motor Requirements for Process Equipment."

**1.2 REFERENCES**

- A. Definitions:
  - 1. HDPE: High Density Polyethylene
  - 2. ID: Inner Diameter
  - 3. MGD: Million Gallons per Day

**1.3 ADMINISTRATIVE REQUIREMENTS (NOT USED)**

**1.4 SUBMITTALS**

- A. Submittals shall be prepared in accordance with Section 01 33 10-PS "Supplier Submittals."
- B. Action Submittals:
  - 1. Product Data:
    - a. Submit manufacturer's descriptive literature and product specifications for each product.
    - b. Include installation details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, and
    - c. Include installation details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, and furnished specialties and accessories.

2. Shop Drawings:
  - a. The following items shall be submitted with the Shop Drawings:
    - 1) Catalog data or illustrations showing principal parts and materials.
    - 2) A complete set of all layout drawings and details including complete assembly and installation drawings including overall equipment layout and piping interconnection drawings.
    - 3) Complete electrical schematics and field termination drawings.
    - 4) Complete data for accessory items.
    - 5) Detailed specifications and data including the following:
      - a) Motors
        - Manufacturer
        - Type and model
        - Horsepower rating and service factor
        - Insulation class
        - Temperature rise full load
        - Rotative speed
      - 6) List of recommended spare parts.
3. Test Reports
  - a. Test results for odor control equipment as described in this specification.
- C. Informational Submittals:
  1. Special shipping, storage and protection, and handling instructions.
  2. Supplier's instructions for installation.
  3. Qualifications of field service engineer
  4. Warranty Documentation
  5. Location of nearest service center and spare parts stock distributor.
- D. Operation and Maintenance Data:
  1. Complete operation and maintenance data for all equipment and controls in accordance with Section 01 33 00 and Section 01 78 23. Operation and maintenance data shall include a description of the modes of operation and limits of operation for each component.

## 1.5 QUALITY ASSURANCE

- A. EQUIPMENT SUPPLIER shall have provided a minimum of five (5) individual systems of similar size for this Project in satisfactory operation for at least two (2) years.
- B. All manufacturer parts and components shall be engineered for long, continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts.
- C. Where like items are incorporated into equipment systems (i.e. motors, push buttons, etc.), such items must be identical to achieve standardization for appearance, operation, maintenance, spare parts, and service. Corresponding parts of multiple units shall be interchangeable.



- D. Assembly and wiring shall be to the point where only field interconnections to numbered terminal blocks are required.
- E. Parts and service shall be available within 50 miles of the lift station and project site for immediate repairs should service become necessary. Unless it can be demonstrated that parts are available at a service center through the same financially sound firm on a continuing basis.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store all components to be installed under this section in accordance with the EQUIPMENT SUPPLIER'S written Pre-Installation Delivery, Storage, and Handling Instructions and the requirements of Section 01 60 00-PS.

#### 1.7 WARRANTY

- A. Extended Equipment Warranty: Refer to Section 01 78 36 "Warranties" for extended equipment warranty.
- B. All equipment furnished under this section shall have a special equipment warranty, in accordance with the Contract Documents, for a period of two (2) years after the date of Substantial Completion. The cost of removal, shipment, repair, and installation by CONTRACTOR shall be included in the warranty and correction of defective work.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Reliant Water Technologies
- B. Or Engineer Approved Equivalent

#### 2.2 PROCESS REQUIREMENTS

- A. Lift Station Design Details
  - 1. The influent lift station is a 10-ft diameter by 18-ft deep raw sewage wet well with 3 pumps installed and a slot for a 4<sup>th</sup> future pump.
  - 2. Surface Water Depth:
    - a. Minimum: 5.5 ft
    - b. Maximum: 10 ft
  - 3. Flows:
    - a. Average Daily Flow: 0.25 MGD
    - b. Max Daily Flow = 0.58 MGD
    - c. Peak hourly Flow = 1.0 MGD
  - 4. Wet Well Wizard System
    - a. Quantity of Aerators Required: 1
      - 1) Each unit shall be provided with a minimum of 50 ft of 1-inch ID ADPM air hose.
    - b. Quantity of Blowers Required: 1
      - 1) Blower Motor Rating: 3.0 HP
      - 2) Blower Motor Voltage/Cycle/Phase: 480/60/3

## 2.3 EQUIPMENT

### A. Aeration Ejector

1. An 18" long HDPE tube fitted to a stainless-steel support 6" atop a 5" diameter stainless steel base weighing no less than 10 lbs. The interior of the ejector tube will be fitted with no less than 4 circular bubble cleaving disks made of HDPE with 1 flat edge each, situated in an antipodal manner as to cleave and spin large bubbles as they rise through the tube.
2. The reinforced, double walled hose must enter the ejector from the dorsal end and pass through each cleaving disk, ending below the bottom disk in such a way as to terminate with a brass outlet nipple held in place with a stainless-steel clamp.
3. All hardware holding the antipodal cleaving disks in place must be stainless steel and welded to the cleaving disks.
4. The ejector tube must be positioned in a vertical orientation in the wet well and there will be no holes in the tube other than at the dorsal and bottom ends of the tube. No air entering the tube can escape the bottom end of the tube near the intakes of pumps situated in the bottom of the wet well. No air escaping the ejector will be in a fine bubble configuration. The ejector is strictly a coarse bubble ejector.

### B. Blower

1. The air source shall be a side channel, two stage, low volume, high pressure regenerative blower with an air release valve, plumbing for one or more wet well aeration ejectors, and a weather-proof pressure gauge for the purpose of aerating and agitating the liquid in a sewer or lift station wet well.
2. The blower motor and flywheel specifications must be sized to accommodate the necessary pressure and air volume to properly aerate and agitate the water in a specific wet well, taking into consideration the well surface area, altitude, and water depths, including low water and high-water depths.
3. The wet well water agitation must be aggressive enough to continuously cause wave surges across the entire wet well surface.
4. Two blowers functioning together must be capable of supplying enough air volume and pressure for enough aeration ejectors to completely affect the entire surface of the wet well. It is important that no air from the air source can reach the intakes of underwater pumps in the wet well.

### C. Air manifold

1. The air source will have a stainless-steel manifold with the necessary number of air outlet ports to supply air to the required number of aeration ejectors identified in this specification.
2. Each port will utilize stainless steel cam lock hose connectors to accommodate the required number of air feed hoses.
3. There will be a Water gauge located on the primary manifold feed pipe.

### D. Air Feed Hose

1. 1. 1.25" OD, 1" ID, reinforced, double walled, PVC and polyurethane hose of variable lengths for the connection of the regenerative blower to each ejector tube in the wet well. Each end of the air feed hose must terminate with a mating stainless steel cam lock fitting for the air source manifold and the aeration tube or tubes.

- E. Air Feed Hose Connecting Hardware
  - 1. All nipples and cam lock fittings for the hose between the regenerative blower and the aeration ejector in the wet well are to be made of either stainless steel or brass.

2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 40 05 93-PS "Common Motor Requirements for Process Equipment" for motors, 600 volts and lower, and 250 HP and smaller. Requirements of this Section supersede any conflicting requirements of Section 40 05 93-PS.
- B. Motors shall be inverter rated duty, when indicated. When inverter rated duty is required, provide statement of compliance that the motors are capable of operation with variable frequency drives.
- C. Motor Sizes: Motor size and detail requirements shall be as indicated in the Design and Performance Criteria table at the End of Section. Motors shall be properly sized so that the driven loads will not require the motor to operate in service factor range above 1.0 along the complete operating range.
- D. If a motor horsepower rating larger than specified is offered as a substitute and accepted, provided required changes in conductors, motor controllers, variable frequency drives, overload relays, fuses, switches and other related items with no change in the Contract price.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment in accordance with the Drawings, approved shop drawings, and the EQUIPMENT SUPPLIER's instructions. The location of the air compressor and hose penetrations are approximate. The precise placement and alignment of anchor bolts, hose manifold, and associated connections shall be in accordance with the supplemental construction details provided by the equipment manufacturer. The contractor and manufacturer shall verify and check installation during start up field testing. Improper installation shall be corrected by the CONTACTOR prior to continuation of testing.
- B. Comply with the requirements of all Division 1 Sections.

3.2 MANUFACTURER'S FIELD SERVICES.

- A. The services of a qualified Manufacturer's technical representative shall be provided for installation inspection, testing, startup and training. The system Manufacturer shall include the following site visits and days on site:

Service	Number of Trips	Number of Days/Trip
Installation Inspection, Commissioning, Training and Testing	2	2

3.3 FIELD TESTING

- A. Verify equipment runs as expected with no visible or audible leaking. Ensure

motors/blowers turn on and off when functioned. Verify isolation valves properly isolate the line and ejector while still allowing the rest of the system to function.

### 3.4 SYSTEM STARTUP

- A. Startup of the facility shall be in accordance with Section 01 75 25.
- B. Installation Assistance and Inspection:
  - 1. After Equipment Installation and before startup, the CONTRACTOR and SUPPLIER Field Representative shall inspect the installation of the equipment. A preliminary running period (as applicable) will be provided for the CONTRACTOR to make field adjustments with the SUPPLIER Field Representative. CONTRACTOR shall submit a report for SUPPLIER approval of equipment installation.
- C. Functional Test:
  - 1. CONTRACTOR to start up equipment with SUPPLIER Field Representative. Equipment shall be able to run in manual mode with all associated piping, electrical and equipment installed to show proper equipment operation. Functional Test shall be 5 days of uninterrupted service. The CONTRACTOR shall be responsible for equipment operation for the 5-day period. Any delays or additional person days and trips required for SUPPLIER Field Representative to perform Functional Testing beyond what is specified is the CONTRACTOR's responsibility. Functional Test can be run with clean water to demonstrate equipment operation.
- D. Performance Test and Initial Training:
  - 1. CONTRACTOR and SUPPLIER Field Representative to start up equipment in Automatic Mode (Normal Operation). Equipment shall run in 2 modes: normal operation and peak flow conditions. CONTRACTOR and SUPPLIER Field Representative should demonstrate any alarms, lead lag conditions, or total auto mode or other conditions related to equipment operation. Performance Test shall run with uninterrupted service for 30 days. Performance Test shall be run with wastewater under normal operating conditions. If equipment fails before 30 days, SUPPLIER shall correct problems at their own expense and restart the 30 day Performance Test. SUPPLIER and CONTRACTOR are responsible for equipment operation during the 30 day Performance Test. SUPPLIER shall perform initial training at the end of the 30 day Performance Test for OWNER's representative. Training shall be with a draft of the full Operation and Maintenance Manuals. Upon completion of Performance Test and Training, the OWNER shall consider equipment substantially complete and start the warranty period.
- E. Post-Startup Training:
  - 1. SUPPLIER will perform additional training at a time mutually agreeable to the OWNER and SUPPLIER to take place no earlier than 30 days after equipment substantial completion and no later than 90 days after Substantial Completion.

**END OF SECTION**

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